

EDN[®]

SPECIAL ISSUE—Part 2
Product Showcase No 25

Highlighting key trends in
components, instruments,
computers & peripherals, and
computer-aided engineering

Expanded literature section

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



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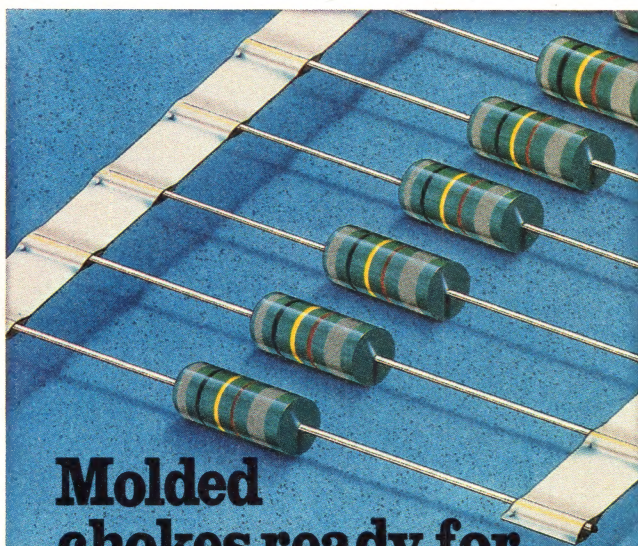
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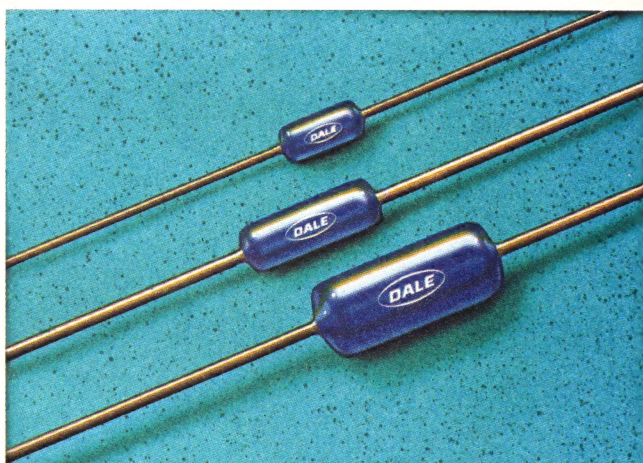
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CIRCLE NO 157



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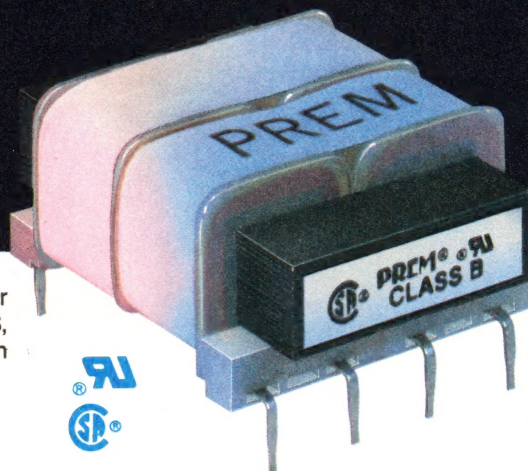
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CIRCLE NO 117

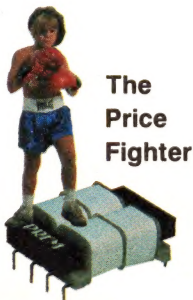


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LOW PASS	Model	*LP-	10.7	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to			10.7	32	48	60	98	140	190	270	400	520	580	700	780	900
Max. 20dB Stop Frequency (MHz)			19	47	70	90	147	210	290	410	580	750	840	1000	1100	1340
Prices (ea.): P \$9.95 (6-49), B \$24.95 (1-49), N \$27.95 (1-49), S \$26.95 (1-49)																

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Pass Band (MHz) start, max.			41	90	133	185	290	395	500	600	700	780	910	1000
end, min.			200	400	600	800	1200	1600	1600	1600	1800	2000	2100	2200
Min. 20dB Stop Frequency (MHz)			26	55	95	116	190	290	365	460	520	570	660	720

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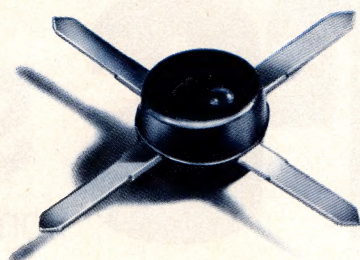
*Prefix P for pins, B for BNC, N for Type N, S for SMA example: PLP-10.7

CIRCLE NO 209

C105 REV. C

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from



dc to 2000 MHz amplifier series

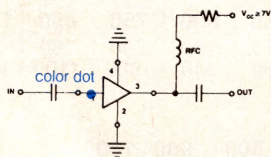
SPECIFICATIONS

MODEL	FREQ. MHz	GAIN, dB				MAX. PWR. dBm	NF dB	PRICE \$	
		100 MHz	1000 MHz	2000 MHz (Note)	Min.			Ea.	Qty.
MAR-1	DC-1000	18.5	15.5	—	13.0	0	5.0	0.99	(100)
MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

NOTE: Minimum gain at highest frequency point and over full temperature range.

designers amplifier kit, DAK-2

5 of each model, total 35 amplifiers
only \$59.95



Unbelievable, until now...tiny monolithic wide-band amplifiers for as low as 99 cents. These rugged 0.085 in.diam., plastic-packaged units are 50ohm* input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer up to 33 dB gain, 0 to +11dBm output, noise figure as low as 2.8dB, and up to DC-2000MHz bandwidth.

*MAR-8, Input/Output Impedance is not 50ohms, see data sheet.
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120 x 60	10%	X7R	.022, .047, .068, .1µf

* Minimum Order 50 per Value

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On the cover: Part 2 of Product Showcase No 25 describes vendors' offerings in four product categories: computers and peripherals, components, computer-aided engineering, and instruments. Leading off the products sections are in-depth looks at high-capacity floppy-disk drives (pg 88), EMI products and services (pg 154), CASE tools (pg 220), and in-circuit emulators (pg 252).

DESIGN FEATURES

EDN's Hands-On SMT Project—Part 5

69

When they came off the manufacturing line, our boards didn't work at all. To find out why, we handed them to ATE engineers, who found the defects on each board. The information they provided allowed us to repair the defects and eventually produce a working SMT assembly.—*Steven H Leibson, Regional Editor*

Computers and Peripherals

Floppy-disk drives store 3M to 20M bytes in niche applications

88

Disk drives that use removable flexible media now reliably offer formatted capacities as high as 20M bytes. However, several factors have combined to limit the drives' use.—*Maury Wright, Regional Editor*

Components

FCC regulations encourage you to shield EMI selectively

154

The FCC has cracked down hard on home computers and peripherals—the most prevalent source of electromagnetic interference. Yet EMI products and services can help you comply with these regulations. And by considering EMI at the planning stages, you can cut the overall shielding costs too.—*Tarlton Fleming, Associate Editor*

Computer-Aided Engineering

CASE tools run on an expanded range of computer systems

220

Once available only for the largest computers, CASE tools now suit a range of computers and applications. The various tools can be invaluable for creating maintainable software and for heading off potentially devastating problems.—*Chris Terry, Associate Editor*

Instruments

In-circuit emulators keep pace with 16- and 32-bit μ Ps

252

Although the basic job of in-circuit emulators has not changed, the complexity of the microprocessors they emulate has. Nevertheless, many emulators can deal with the high-level languages and at the fast clock speeds of today's μ Ps.—*Chris Everett, Regional Editor*

Continued on page 7



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8842A-05K IEEE-488 Field Kit \$170





Product coverage in this showcase issue begins with a review of innovative computers and peripherals (pg 98). Coverage continues with reviews of components (pg 165), computer-aided engineering (pg 233), and instruments (pg 267).

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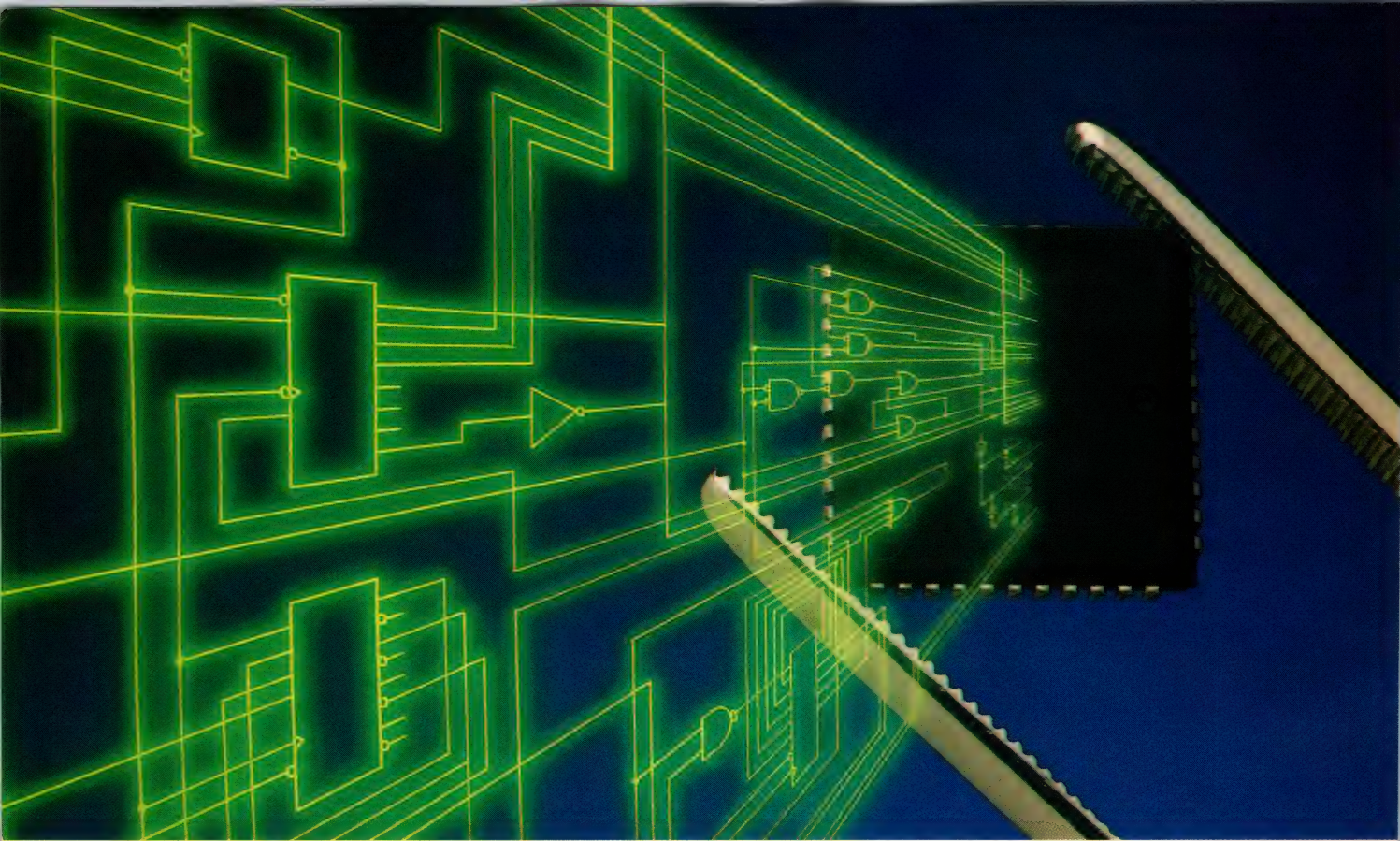
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EDITORIAL

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Although IBM's new computers get a lot of attention, there's still life left in older PCs.

PROFESSIONAL ISSUES

338

For three test engineers, Atlantic City's slot machines are more than fun and games.—*Deborah Asbrand, Associate Editor*

LOOKING AHEAD

348

Bar-code market to grow 18.6% annually to 1992... Market for EDI to reach \$1B by 1994.

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A product-oriented design aid

To save you time in your efforts to keep current, EDN's editors have surveyed the new-product offerings from thousands of companies, screening and selecting only the most significant of those offerings introduced in the last six months. We present our findings—the best of the best—in a format designed to make your product selection as easy as possible. You can keep this Product Showcase as a reference until the next one that covers these four key product areas appears in December.

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STAYED

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Device	Process	Access Times
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IMS1420M (x4)	NMOS	45, 55, 70ns
IMS1403M (x1)*	CMOS	35, 45, 55ns
IMS1423M (x4)	CMOS	35, 45, 55ns

64K CMOS SRAMs	
Device	Access Times
IMS1600M (x1)*	45, 55, 70ns
IMS1620M (x4)*	45, 55, 70ns
IMS1624M (OE, x4)*	45, 55, 70ns
IMS1630M (x8)*	45, 55, 70ns

MILITARY DRAMs		
Device	Process	RAS Access Times
IMS2600M (64Kx1)	NMOS	100, 120, 150ns
IMS2800M (256Kx1)	CMOS	80, 100, 120, 150ns
IMS2801M (256Kx1)	CMOS	80, 100, 120, 150ns

*Also available as Low Power Battery Backup CMOS SRAMs with I_{dr} of 10μA (typical I_{cc} at 2V at 25° centigrade).

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MIL-STD-883C RAMs



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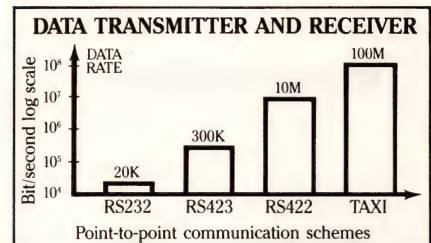
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Conventional wisdom is fine. For conventional designs.

Imagine a parallel-to-serial converter that lets you move data at 100 Megabits per second. Imagine it working like a register, shooting data into a latch that's stretched from point to point, letting that data race, transparently, ten times faster than conventional wisdom says it can go.

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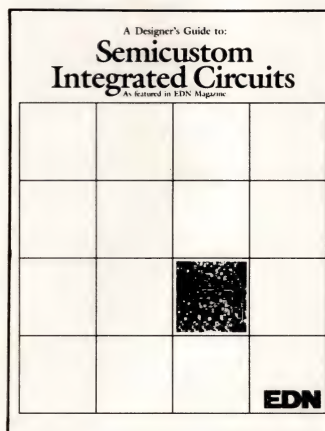
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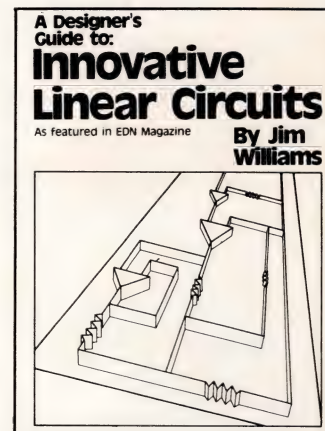
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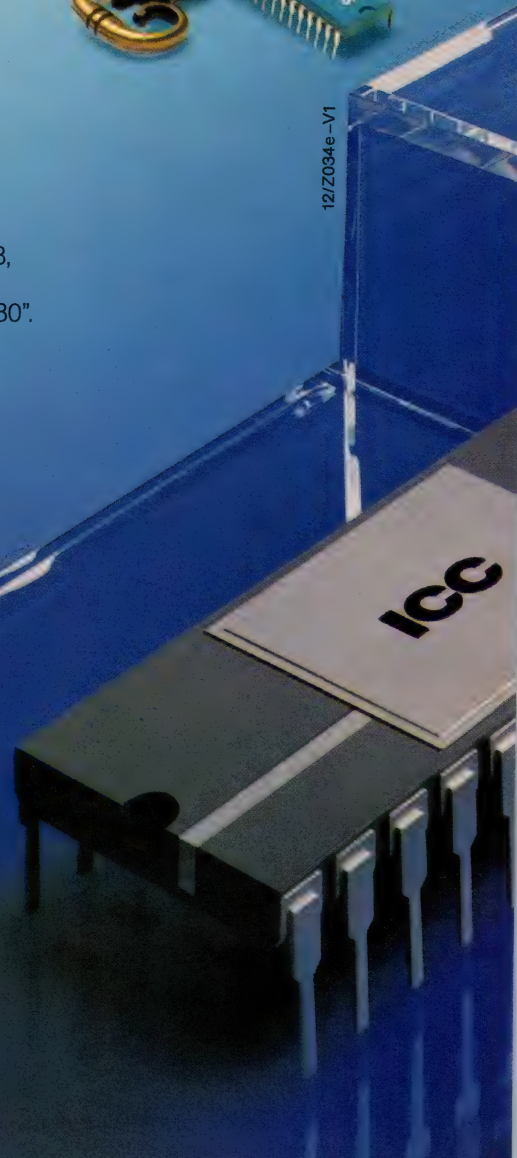
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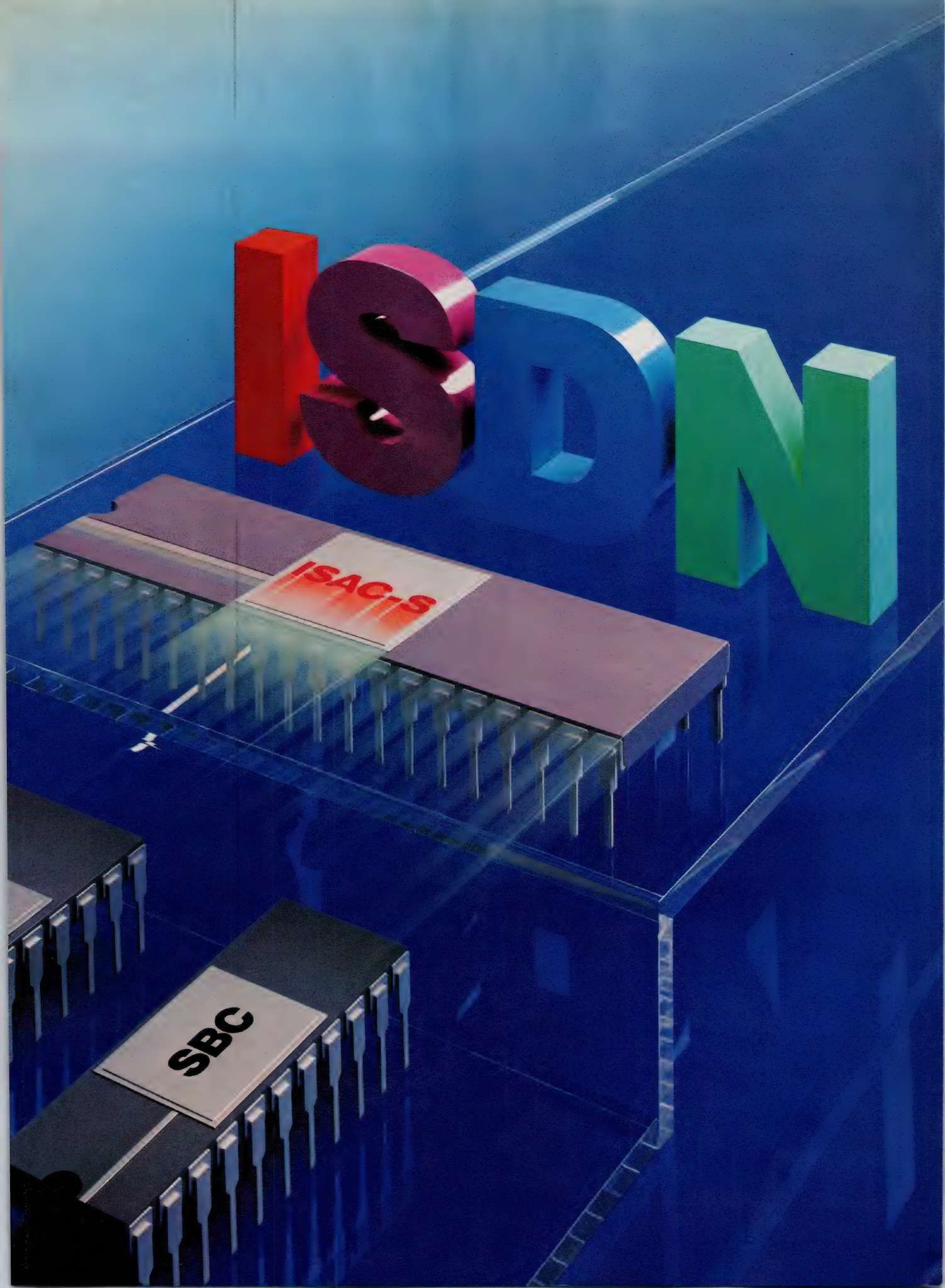
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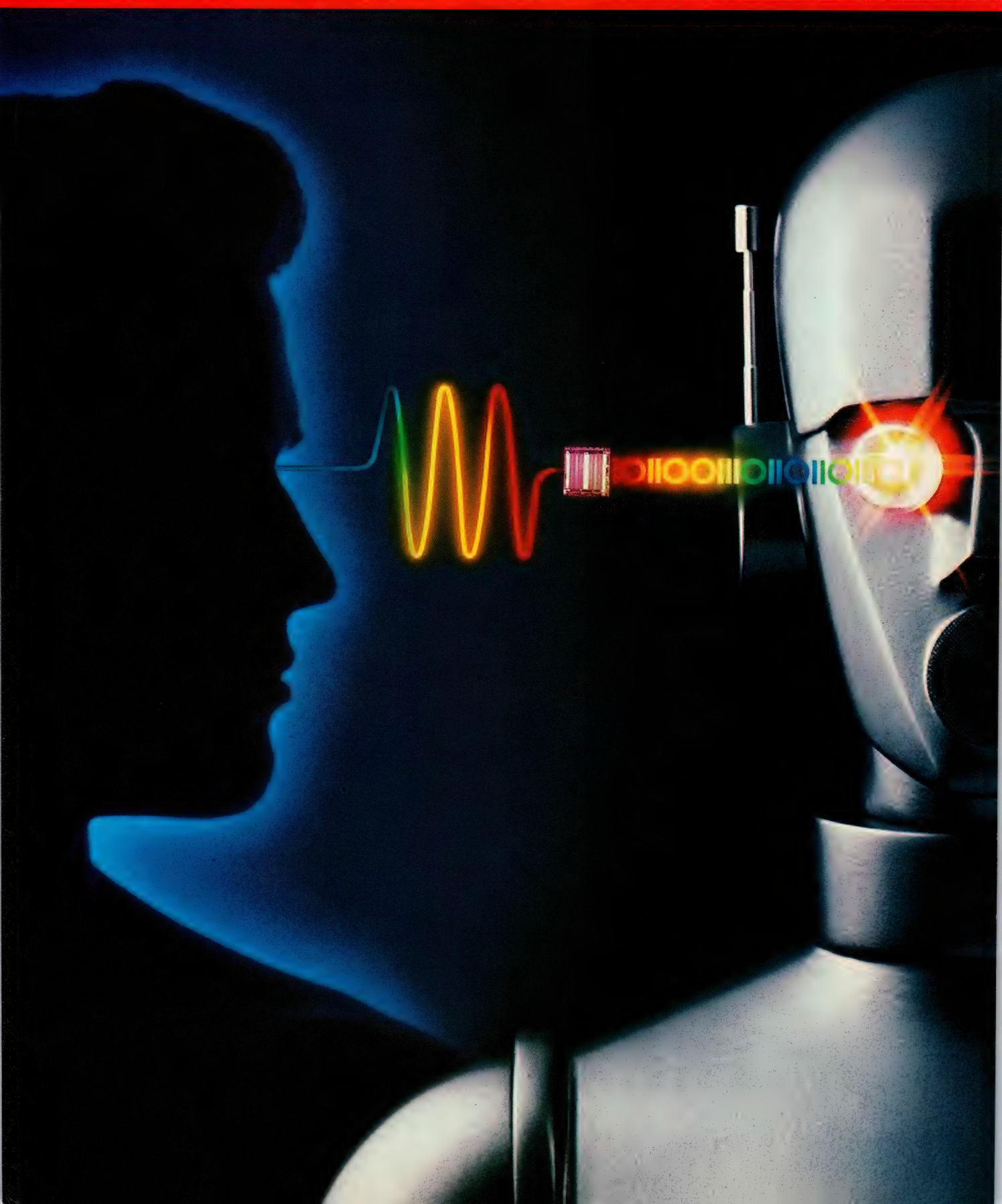
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10-bit CMOS charge balancing ADC.

This 10-bit successive approximation ADC captures fast moving signals, providing excellent resolution.

It features a built-in fast track and hold, with conversion rates of 150 KHz and an input bandwidth of 1.5 MHz. Even at the maximum rate, power consumption is less than 20 mW.

10-bit CMOS serial ADC.

The CDPHC68A2E is selectable for either 8- or 10-bit resolution and has an 8-channel multiplexer allowing up to 8 channels of inputs. The device can be used directly with our CDP68HC05C4 or D2 microprocessors or other similar SPI (Serial Peripheral Interface) buses.

8-bit CMOS R-2R video-speed DAC's.

These CMOS/SOS digital-to-analog converters operate

from a single 5V supply at video speeds and can produce "rail-to-rail" output swings.

Typical update rate is 50 MHz. Settling is fast (20 ns typical) to 1/2 LSB. "Glitch" energy is minimized by segmenting and bar graph decoding of upper 3 bits.

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Specially designed for use with data converters, the CA3450 op amp has excellent speed and transmission line driving capabilities.

For 10-bit accuracy, it settles to within 1/2 LSB in 40 ns with a 2V input signal. And it can drive up to four 50 ohm transmission lines.

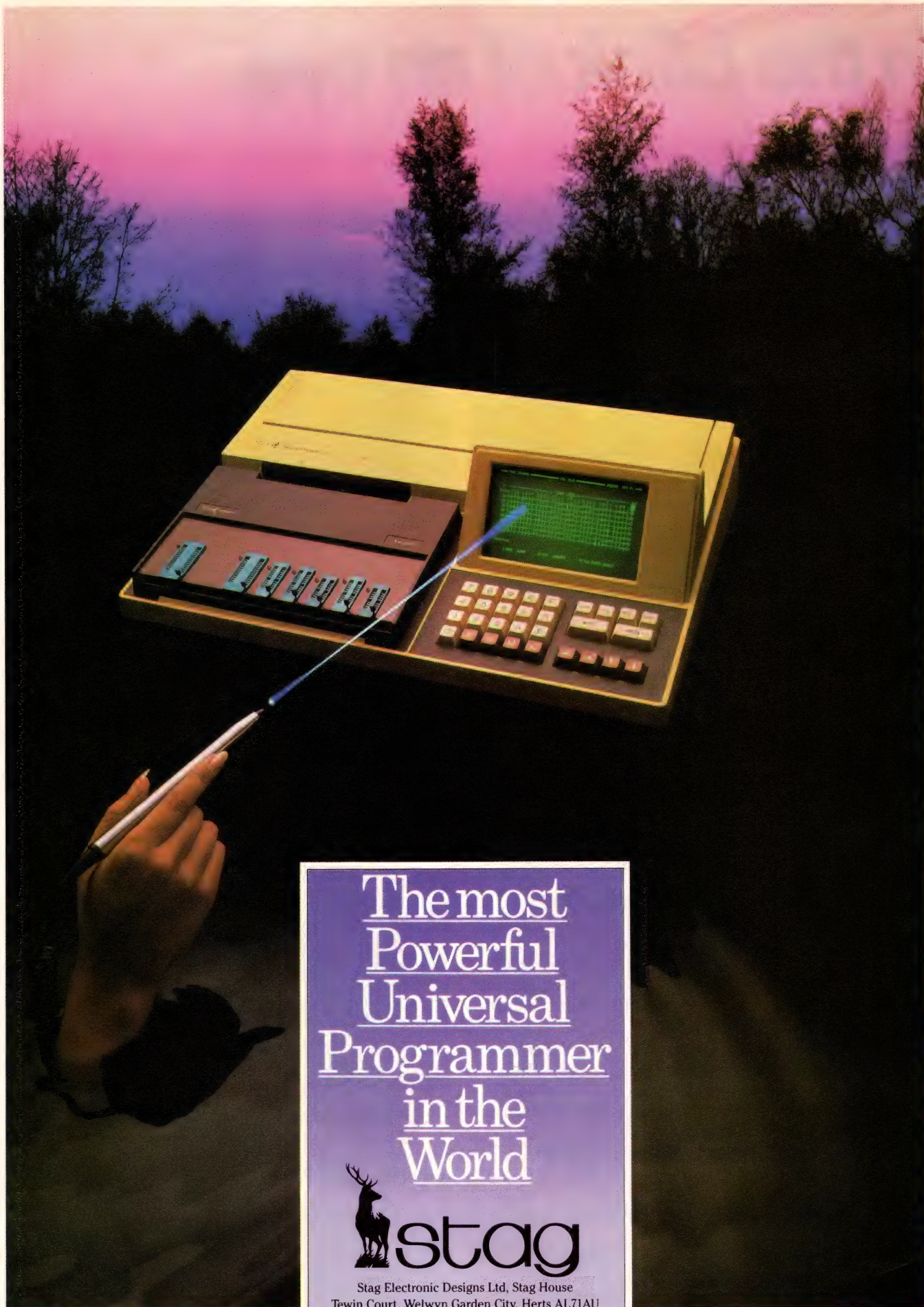
ADC's	Res. Bits	Conv. Rate Hz	Power Diss. (mW)	Pkg. Leads	1K Price
CA3304E	4	20M	30	16	2.95
CA3304AE	4	25M	35	16	6.50
CA3306CE	6	10M	65	18	5.50
CA3306E/3306AE	6	15M	70	18	6.25/11.25
CA3318E/3318CE	8	15M	150	24	38.50/24.00
CA3310E/3310AE	10	150K	15	24	6.00/8.00
CDP68HC68A2E	10	10K	15	16	3.75
DAC's					
CA3338E/3338AE	8	50M	100	16	6.00/3.40
OP AMP					
	UGBW Hz	Slew Rate (X10)	I _{OUT} mA	Pkg Leads	1K Price
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NEWS BREAKS

EDITED BY JOAN MORROW

PAIR OF 4-CHANNEL SCOPES OFFERS HIGH-FREQUENCY DIGITIZING

Two digitizing oscilloscopes from Hewlett-Packard Co (Palo Alto, CA) allow you to capture high-frequency signals on as many as four channels simultaneously. The \$22,900 HP54112D features an input bandwidth of 100 MHz for both repetitive and single-shot measurements, a 400-MHz digitizing rate, and six bits of resolution. For very-high-frequency measurements, the \$27,850 HP54120T features an input bandwidth of 20 GHz with 12-bit resolution. Because the 20-GHz scope uses sequential sampling, capturing only one data point per trigger, you can't use this instrument for single-shot measurements. However, the product does include a time-domain reflectometer built into its first input channel, which allows you to make impedance and reflectance measurements without additional equipment. The scopes have four input channels, color displays, and extensive calculation aids for signal analysis.—Steven H Leibson

FM NARROWBAND RECEIVER ON A CHIP ACCEPTS SIGNALS TO 180 MHz

Operating from power supplies as low as 2V, the \$1.80 (100) MC3362 FM narrowband receiver from Motorola Inc (Phoenix, AZ, (602) 897-3842) incorporates all of the essential functions for a VHF receiver, from the antenna input to the audio preamplifier output. The device consumes between 6 and 35 mW, accepts RF inputs to 180 MHz (or 400 MHz if you generate the first local oscillator signal externally), and features a data-slicing comparator that can recover FSK data at rates of 30k bps.—Steven H Leibson

LEDs FIT IN SMALL T-1 PACKAGE

If space is a major consideration in your LED-indicator designs, consider the 125-MRG LED from Data Display Products (El Segundo, CA, (213) 640-0442). The device fits both a red and a green die in a T-1 package, instead of the usual T-1 $\frac{3}{4}$. You can display three colors: red, green, and amber when both dies are on. The 125-MRG costs \$0.20 (1000).—Margery S Conner

BOARD OFFERS GPIB INTERFACE FOR MICRO CHANNEL COMPUTERS

If you want to use one of the new IBM Personal System/2 computers to control your IEEE-488 instruments, consider the ZT/2 from Ziatech Corp (San Luis Obispo, CA, (805) 541-0488). This GPIB interface plugs into IBM's Model 50, 60, and 80 Micro Channel computers. The \$395 board specs data rates reaching 300k bytes/sec. A watchdog timer monitors your IEEE-488 devices and prevents system hang-ups by generating periodic interrupts and identifying devices that don't respond promptly. An onboard hardware-based security option lets you protect your software from unauthorized copying. The ZT/2 plugs into IBM's PS/2 Micro Channel and provides interrupt levels, DMA channels, and controller/peripheral mode selection. The board uses no DIP switches or jumpers; instead, you use software to configure the interface via an Adaptor Description file.—J D Mosley

MONOLITHIC IC COMBINES 10-BIT ADC AND 8-CHANNEL MUX

The LTC1090 data-acquisition system on a chip from Linear Technology Corp (Milpitas, CA, (408) 942-0810) incorporates a 10-bit A/D converter with a 20- μ sec conversion period, an 8-channel analog multiplexer, and a sample/hold circuit with a 1- μ sec acquisition time, all crammed into a 20-pin DIP. You configure the analog inputs as eight single-ended, four differential, or some mix of single-ended and differential inputs through the IC's control word. The device features a serial output compatible with Motorola's SPI, National Semiconductor's Microwire, Hitachi's SCI, and TI's

NEWS BREAKS

TMS7000 single-chip μ C serial protocols. You can configure the output to supply data in 8-, 10-, 12-, or 16-bit words to accommodate your μ P's data word. The A/D converter performs either 10-bit unipolar or 9-bit-plus-sign bipolar conversions.

Linear Technology developed a software technique for the LTC1090, dubbed Sneak-a-Bit, that allows you to coax an 11th bit from the A/D converter by performing two unipolar conversions on a differential channel and redefining the polarity of the differential inputs between the first and second conversion. Only one of the conversions will produce a meaningful result; the other conversion will produce either all ones or all zeros, allowing your software to infer a sign bit. The IC operates on 5, 10, or ± 5 V power supplies while drawing only 1 mA. In a plastic package, an LTC1090 rated for 40 to 85°C operation costs \$11.95 (100).—Steven H Leibson

INTERFACE MODULE SUPPORTS 80386 μ P DEVELOPMENT

Hewlett-Packard Co (Palo Alto, CA) has announced a planned upgrade path and a monetary incentive for customers who want to develop 80386 software on its 64100 development system. While the company's hardware emulator for the μ P is still under development, HP is offering the \$2400 64659A processor interface that works in conjunction with its \$7180 64620S logic-state analyzer to provide real-time logic-state capture and reverse code assembly. Purchasers of the processor interface receive a \$5000 credit toward the 80386 in-circuit emulator when it becomes available. This offer expires when HP introduces its 80386 emulator. So if you are developing 80386 code and already have the logic-state analyzer, you could save \$2600 when you buy the emulator.—Steven H Leibson

RAD-HARD GATE-ARRAY FAMILY OFFERS AS MANY AS 7600 GATES

The five members of the UTB-R family of gate arrays from United Technologies Microelectronics Center (Colorado Springs, CO, (303) 594-8000) remain functional after withstanding radiation doses of 10^6 rads. They also meet full data-sheet specifications after exposures of 2×10^5 rads. The rugged ICs can withstand 2000V electrostatic discharges, and the company claims that they are virtually immune to latch-up. Array sizes range from 1000 to 7600 usable gates and typical utilizations range from 90 to 95% using the company's proprietary Highland CAD tool. Nonrecurring engineering charges range from \$50,000 to \$100,000; device costs depend on which of the gate-array members you select and which IC package you use. DIP, LCC, PGA, flatpack, and cerquad packages are available.—Steven H Leibson

VME BUS CARD SUPPORTS SIX SERIAL CHANNELS, FIBER-OPTIC PORTS

Force Computers' (Los Gatos, CA, (408) 354-3410) \$1090 SIO-2 places six serial channels on the VME Bus using one 68561 multiprotocol communications controller IC for each channel. The serial channels operate at rates of 110 to 38.4k bps and offer RS-232C and RS-422 inputs and outputs. In addition, the \$1290 SIO-2A replaces the interface chips on two of the serial ports with fiber-optic ports. An optional front panel for the board costs \$150.—Steven H Leibson



Good news for military customers who need highest performance CMOS:

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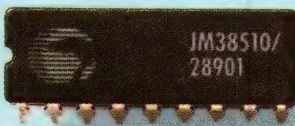
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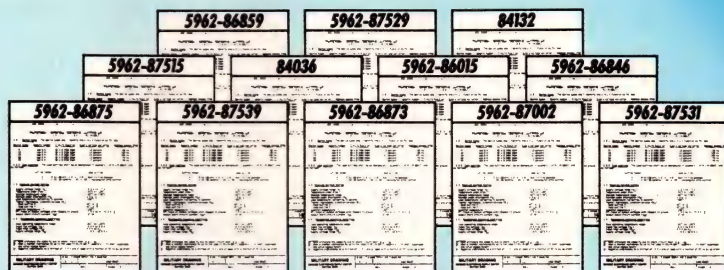


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NEWS BREAKS: INTERNATIONAL

MULTIBUS II CPU CARDS ALLOW 32-BIT USER EXPANSION

Second-generation Multibus II CPU cards from Siemens (Munich, West Germany, TLX 5210025) feature the company's OME (onboard module expansion) interface—a 32-bit bus that allows you to plug in a range of piggyback boards to extend local memory or increase board functionality. The 80186-based OSM-B17, which sells for approximately DM 4900, has 1M byte of RAM, four serial I/O ports, and SCSI and Centronics-compatible ports.

The 80386-based OSM-B37, which sells for approximately DM 11,500, features a 64k- to 256k-byte cache memory, 2M bytes of RAM, one serial port, and SCSI Bus and Centronics ports. Both boards feature math coprocessors. Piggyback boards, priced from around DM 500, include interface boards for the company's AMS and SMP buses, and they also provide as much as 4M bytes of additional memory, an 8M-byte memory board, and a graphics board. The company is publishing full details of the OME interface to allow users to design their own piggyback modules.—Peter Harold

SINGLE-BOARD COMPUTER PROVIDES 68020 SUPPORT ON MULTIBUS II

In the 3rd qtr of this year, Tadpole Technology (Cambridge, UK, TLX 818152) will join a small group of manufacturers, which includes Heurikon Corp (Madison, WI) and Microbar Systems (Sunnyvale, CA), that provides 68020-based Multibus II computer boards. Tadpole's TP20/M2 single-board computer supports the Unix System V operating system with a 68020 μ P, a 68881 math coprocessor, a 68851 paged memory-management unit, 4M bytes of dual-port RAM, six RS-232C serial ports, a SCSI Bus interface, which includes a 1k-byte FIFO data buffer, and an Ethernet interface. The board's Multibus II iPSB interface includes an MPC (message-passing-controller) chip and central services module functions.—Peter Harold

US DISK-DRIVE COMPANY TO BEGIN DRIVE PRODUCTION IN SINGAPORE

Control Data Corp (Minneapolis, MN) will establish two manufacturing plants in Singapore this year to produce its Wren II half-height disk memory unit and a high-capacity 3½-in. drive that's currently under development. The company expects volume production to begin in 1988. Also in 1988, Control Data will open an oxide media components plant in Singapore. Oxide media is a magnetic coating that retains stored data on platters within the disk drive. Media from that plant will be sold to other disk-drive manufacturers in Singapore.—Joan Morrow

US ELECTRONICS TRADE DEFICIT WITH JAPAN DECLINES

The US electronics trade deficit with Japan declined in the first quarter of 1987 compared to the first quarter of 1986, according to the American Electronics Association (Santa Clara, CA). The deficit dropped by almost 12% to \$4.6 billion in the first quarter, which amounts to \$600 million less than the \$5.2 billion deficit in the first quarter of 1986. If this pace continues, "the US-Japan electronics trade deficit would finish 1987 at about \$18 billion compared with \$20.4 billion in 1986," says AEA senior VP Ralph J Thomson. The segment that showed the greatest improvement was consumer electronics, which went from a deficit of \$2.1 billion in the first quarter of 1986 to \$1.5 billion in the first quarter of this year.—Joan Morrow



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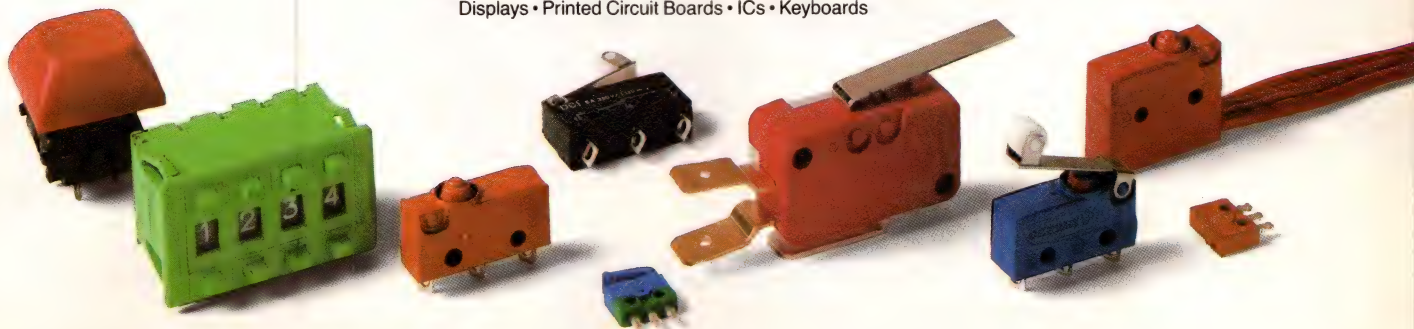


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Switch fast... to Mini-Circuits' KSW-2-46

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FREQ. RANGE	dc-4.6 GHz	
INSERT. LOSS (db)	typ	max
dc-200MHz	0.9	1.1
200-1000MHz	1.0	1.3
1-4.6GHz	1.3	1.7
ISOLATION (dB)	typ	max
dc-200MHz	60	50
200-1000MHz	45	40
1-4.6GHz	30	23
VSWR (typ)	1.3:1	
SW. SPEED (nsec)	2(typ)	
rise or fall time		
MAX RF INPUT (dBm)		
up to 500MHz	+17	
above 500MHz	+27	
CONTROL VOLT.	-8V on, OV off	
OPER/STOR TEMP.	-50 to +100°C	
PRICE	\$32.95 (1-24)	

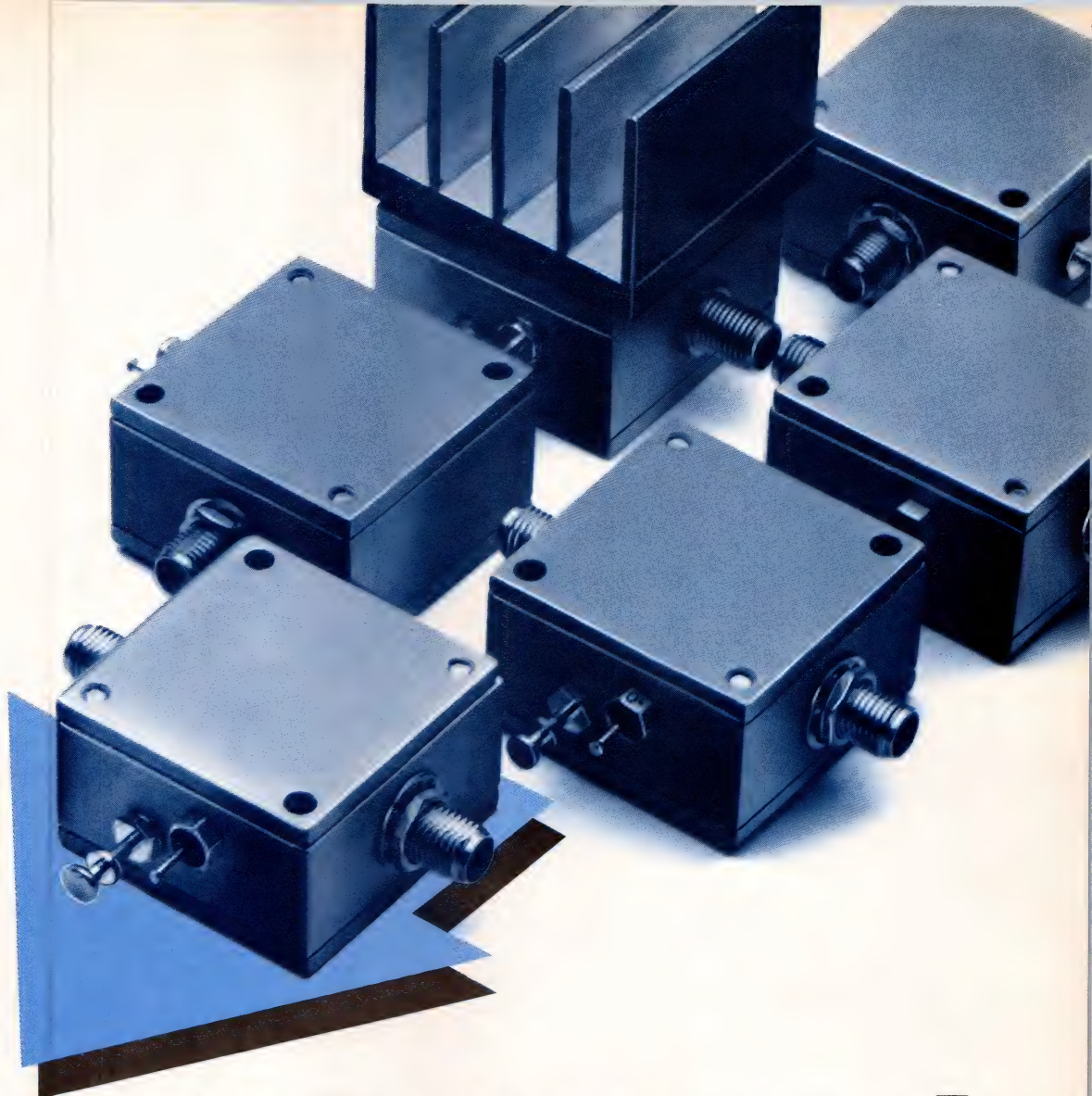
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SPECIFICATIONS

MODEL	FREQUENCY MHz	GAIN, dB (min.)	MAX. POWER OUTPUT dBm(typ)	NF dB(typ)	PRICE \$	
					Ea.	Qty.
ZFL-500	0.05-500	20	+9	5.3	69.95	1-24
ZFL-500LN	0.1-500	24	+5	2.9	79.95	1-24
ZFL-750	0.2-750	18	+9	6.0	74.95	1-24
ZFL-1000	0.1-1000	17	+9	6.0	79.95	1-24
ZFL-1000G*	10-1000	17	+3	12.0	199.00	1-9
ZFL-1000H	10-1000	28	+20	5.0	219.00	1-9
ZFL-1000LN	0.1-1000	20	+3	2.9	89.95	1-24
ZFL-2000	10-2000	20	+17**	7.0	219.00	1-9

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VT20C18	2K x 8	APD; 10 ns OE	20 ns
VT20C19	2K x 8	12 ns CE; 10 ns OE	20 ns
VT20C50	1K x 4	Separate I/O; FC	15 ns
VT20C68	4K x 4	APD	20 ns
VT20C69	4K x 4	12 ns CS	20 ns
VT20C71	4K x 4	Separate I/O; OT	20 ns
VT20C72	4K x 4	Separate I/O; HZ	20 ns
VT20C78	4K x 4	APD; 10 ns OE	20 ns
VT20C79	4K x 4	12 ns CS; 10 ns OE	20 ns
VT20C98*	8K x 8	APD	25 ns
VT20C99*	8K x 8	Fast CE	25 ns
VT62KS4*	16K x 4	15 ns CS	25 ns
VT63KS4*	16K x 4	15 ns CS; OE	25 ns
VT64KS4*	16K x 4	APD	25 ns
VT65KS4*	16K x 4	APD; OE	25 ns

APD=Auto Power Down; CE=Chip Enable; OE=Output Enable; CS=Chip Select; FC=Flash Clear; OT=Outputs Track Inputs During Write; HZ=High-Impedance Outputs During Write *Samples Available 4th Quarter, 1987.

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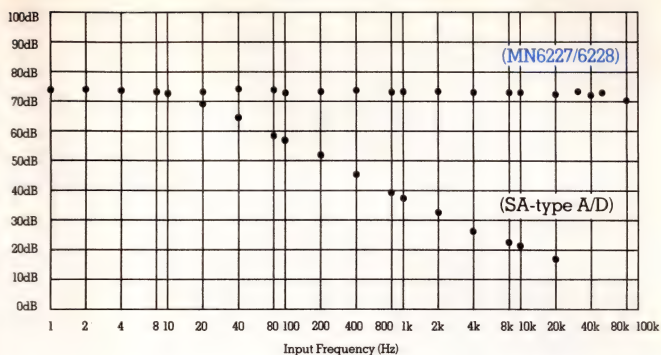
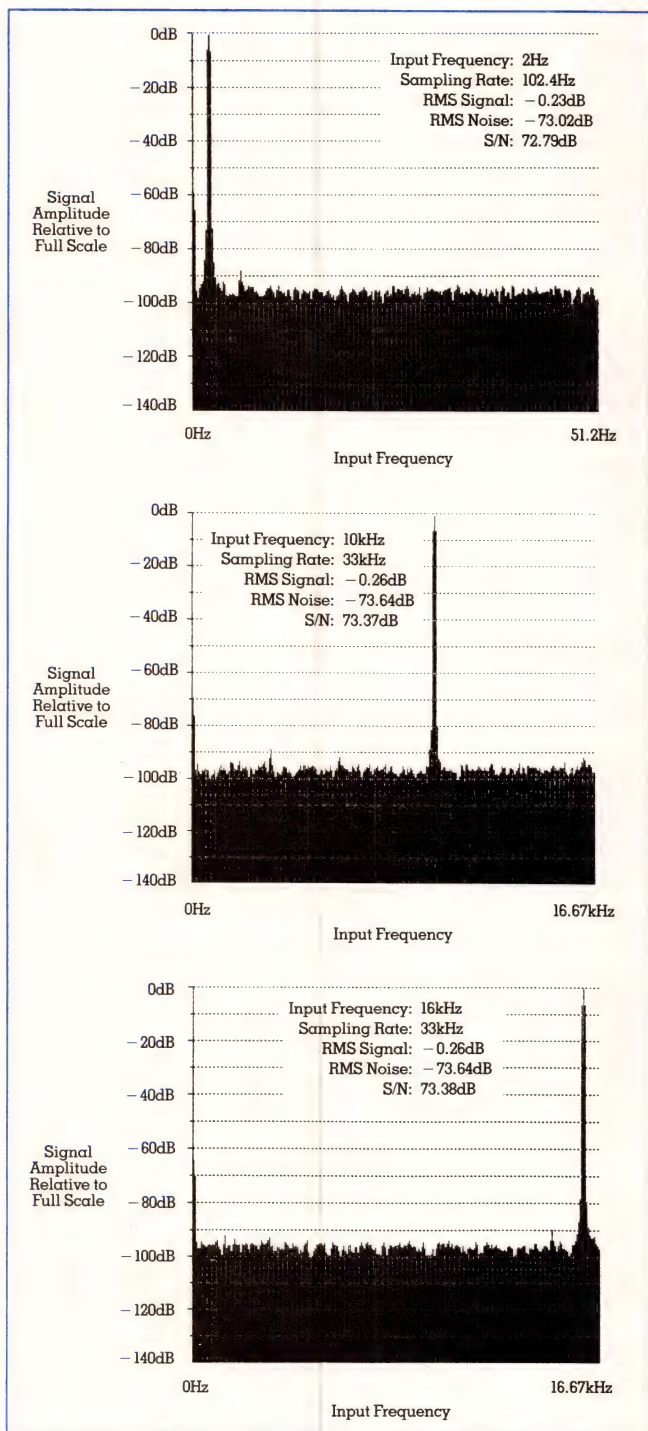


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Note the FFT spectra (right) and the data plot (top right). They clearly demonstrate the ability of these devices to maintain SNR with increasing input frequencies. In our frequency-domain testing, these devices operate in a manner that simulates a

digital spectrum analyzer with a known low-distortion input signal. The output spectra yield precise, practical measurements of signal level, noise level, signal-to-noise ratio, harmonic distortion, and input bandwidth... the keys to specifying for DSP applications.

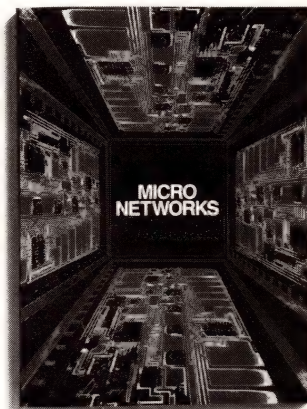


This plot of actual recorded data demonstrates MN6227/6228's ability to maintain near-ideal SNR with increasing input-signal frequency, while A/D's without companion track-holds show rapid (6dB/octave) SNR degradation.

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SIGNALS & NOISE

Analog and digital design differ greatly

I have to shake my head in disbelief at the individuals who have recently written to EDN, exhorting that digital and analog electronic design have "artificial barriers" between them and that the two disciplines are essentially the same. These individuals can't be serious! Evidently, they must have had limited exposure to both fields to make such a claim.

True, the fields do have some things in common, but it's hardly enough to justify such an inane conclusion. To say that the two fields are essentially the same is to imply that an individual could make a relatively easy transition between them. Evidently I must have worked with a lot of incompetent engineers throughout my career: I have not found many digital designers who are well versed in feedback-loop stabilization techniques, nor many analog designers who can develop interfaces to a VME Bus.

The bottom line in this discussion is the issue of employment. If you think there is no significant difference between the two fields, see how far you'll get as an analog designer applying to a company that's advertising for a digital designer (or vice versa). You will find that credentials in one field will not get you very far in the other field.

*Garrison W Greenwood, PE
Eldec Corp
Lynnwood, WA*

TV stations use local sync generators

I appreciate the comments of the American Radio Relay League's Chuck Hutchinson in Signals & Noise (EDN, April 15, pg 30) about our Design Idea "TV sync generator acts as clock timebase" (by Andrew Dart and Richard Kihn, EDN, December 11, 1986, pg 278). He is

absolutely correct: Nearly all local TV stations run their sync generators independently of network sync, so that a loss of the network TV signal won't mean a loss of local sync. The notes I submitted with that Design Idea said that "The local subcarrier frequency is adjusted to match the network subcarrier frequency" The phrase "tracks the network signal" was inserted by EDN editors in the process of interpreting and condensing my notes. I winced when I saw this little error and hoped nobody else would notice.

*Andrew Dart
Trans-Texas Telegraph Co
Duncanville, TX*

(Ed Note: Mr Dart is correct. We apologize for the error.)

Solid-state SLICs will replace transformers

Chris Stacey's article on transformer-based SLICs (EDN, April 30, pg 149) misses a few important points. Although it's true that flux cancellation reduces the deterioration of transmission parameters that's caused by direct current in the coupling transformer, there are still compelling reasons for replacing transformer circuits with solid-state SLICs. Magnetic coupling between transformers often imposes a need for bulky and expensive shielding, in order to achieve tolerable crosstalk.

Furthermore, even with a current ratio of 5 to 1, if a line draws 50 mA, the resulting flux-cancellation current of 10 mA causes an additional half watt of dissipation from the -48V supply in the line circuit—in an area where high circuit density in many cases already imposes a difficult thermal burden on components—as well as corresponding additional dissipation in the power supply. A solid-state SLIC, however, can implement current limiting, which reduces power dissipation even when



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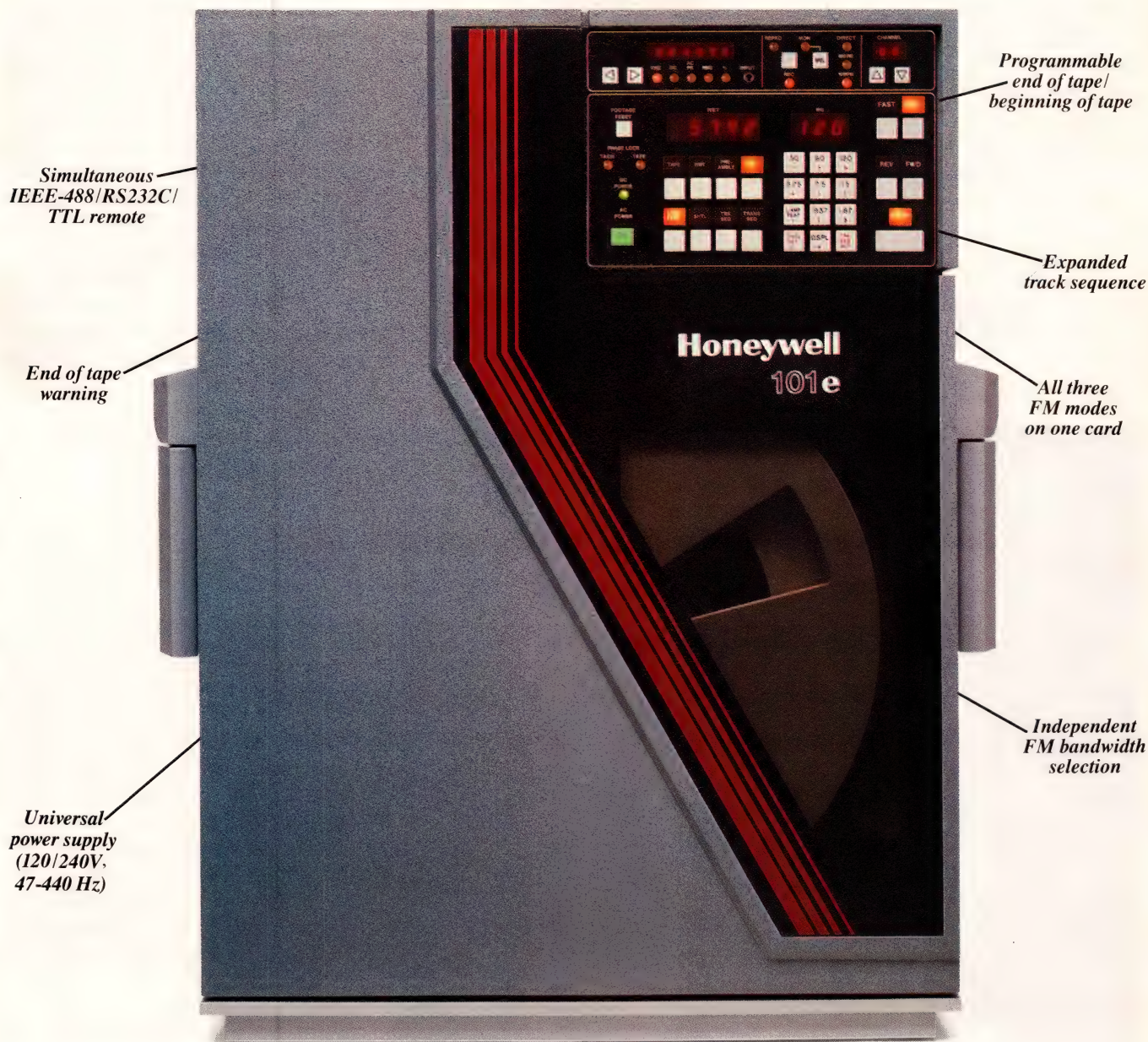
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SIGNALS & NOISE

compared with transformer-based line circuits without flux cancellation.

As to Mr Stacey's assertion that monolithic SLICs are expensive and inflexible, let me point out that the situation is improving. Consider, for example, the central-office SLIC available from both AMD and RIFA. (The product is the only cen-

tral-office SLIC so far to have an alternate source.) That SLIC, in its conventional application, requires a companion product, called a SLAC, which sets transmission parameters by digital signal processing and achieves A/D and D/A conversion. The result is a good, if somewhat pricey, line circuit. Aptek Microsystems has developed a technique for

achieving the same ends without the SLAC, using an ordinary (and inexpensive) codec/filter combination. This technique yields better transmission performance at reduced cost. Our company has been awarded a contract by the telecommunications agency of a European government for the design of line circuits, using this technique, for central-office switches for the country's domestic use. These circuits will replace the present transformer-based line circuit, increasing the line-circuit density from four lines to eight on a line card. Clearly, the days of the transformer-based line circuit are numbered.

Howard Sinberg

*Manager, Product Development
Aptek Microsystems
Deerfield Beach, FL*

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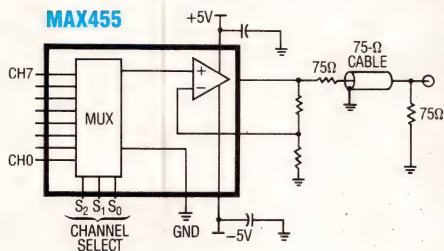
The report in News Breaks on the HSRD1056 resolver-to-digital converter from Natel Engineering (EDN, April 15, pg 19) contained a small error that made a big difference: the words "does not" were omitted from the third sentence. That sentence should read: "In addition, the HSRD1056 contains circuitry to ensure that it *does not* lock into an angle 180° from the true angle when a 180° step function is applied."

YOUR TURN

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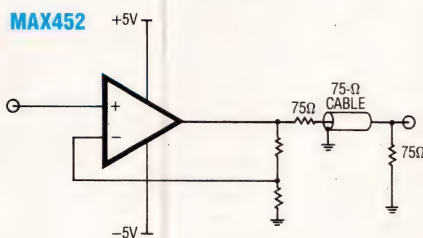
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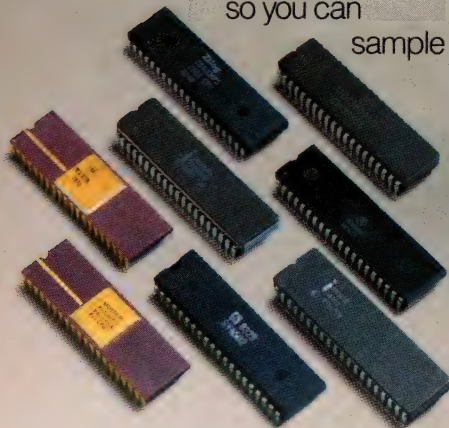
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MON, FEB 02, 1987 State: Memory 4 14:28 IOBOARD

Loc	Bh	Bl	Ah	Al
(00937 differences in displayed bytes)				
0510	88	50	10111101	11111101
0511	D4	50	10111101	11111101
0512	D4	5C	10011101	11111101
0513	D6	7C	11110111	11111101
0514	DE	7E	11110110	11111101
0515	FA	6E	11110110	11111101
0516	17	CB	01010000	11111101
0517	15	EB	00100010	11111101
0518	17	CB	01010000	11111101
0519	39	F9	00100011	11111101
0520	39	99	00001111	11111101
0521	39	50	00111101	11111101
0522	88	50	10111101	11111101
0523	D4	50	10111101	11111101
0524	FA	4E	11011010	11111101
0525	FA	C7	11101000	11111101
0526	59	C7	01101000	11111101
0527	17	C7	01101000	11111101
0528	D6	5C	10011101	11111101
0529	DE	7C	11110111	11111101

Trace:1 Scroll:4 Cur:0,1 Lock:0,1 IBC:2 Load:3 Digi:1

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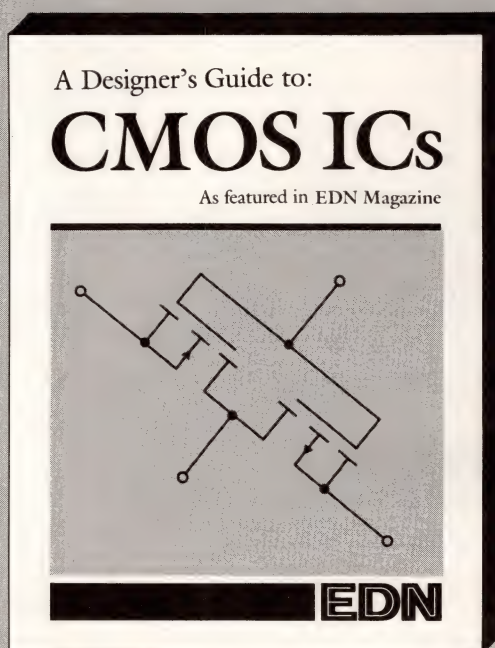
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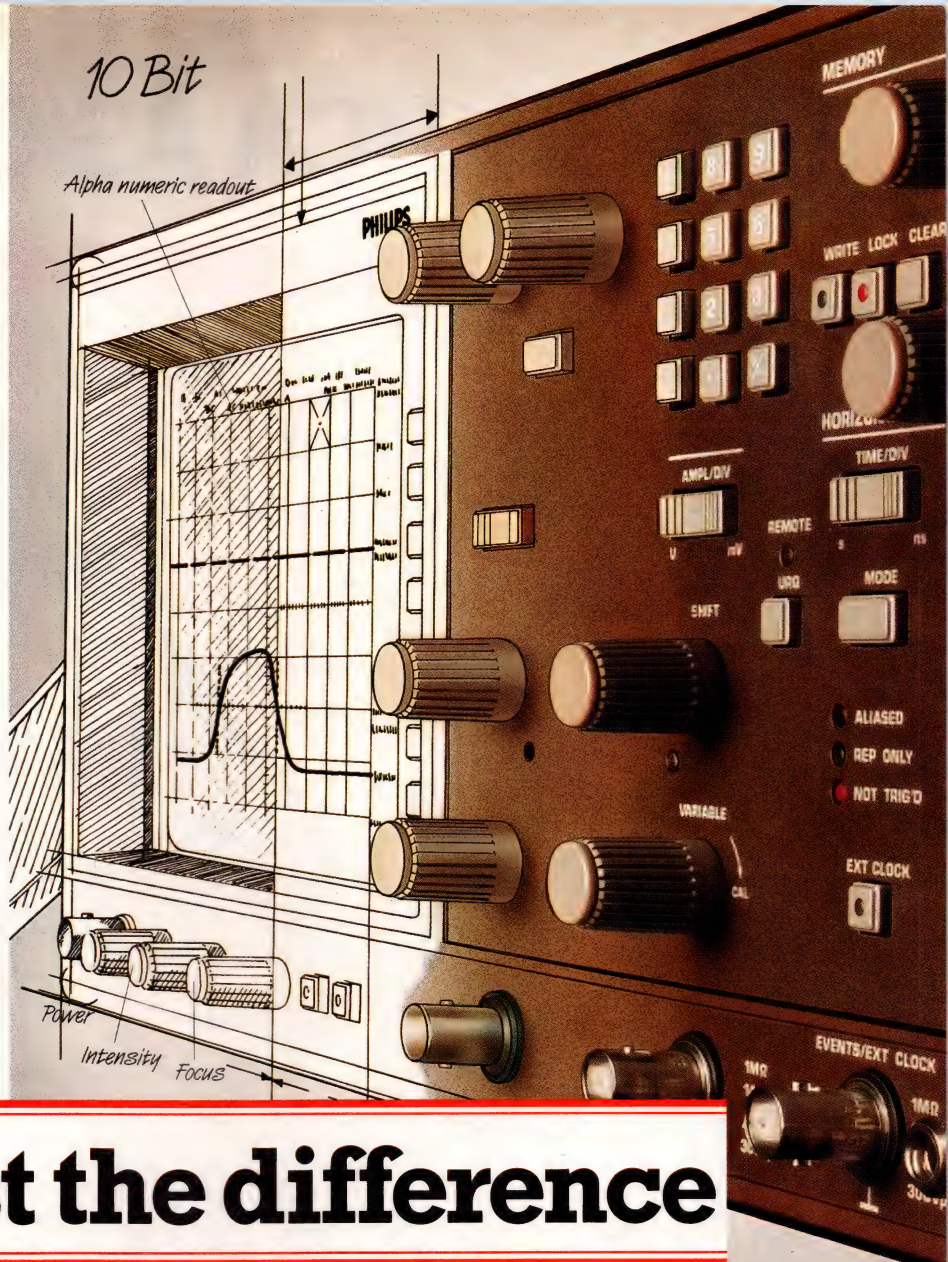
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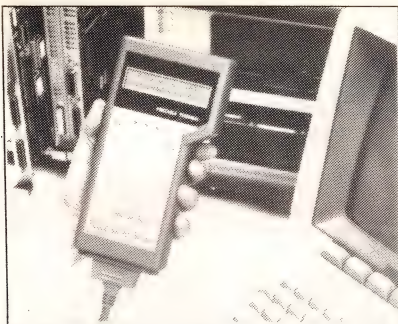
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SIMS '87 (Symposium for Innovation in Measurement Science), Geneva, NY. Instrument Society of America, 67 Alexander Dr, Research Triangle Park, NC 27709. (919) 549-8411. August 2 to 7.

Effective Skills for Technical Managers (short course), San Francisco, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

Hands-On Expert Systems Design and Development (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

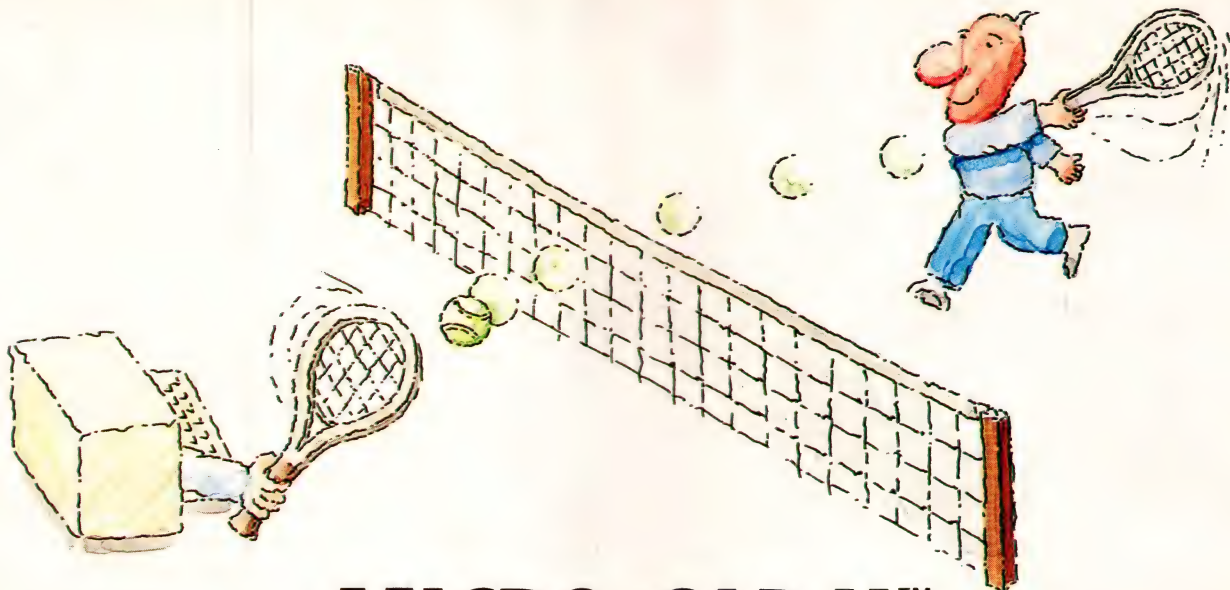
PC-Based Tools for Software Analysis and Design (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. August 4 to 7.

International Computers in Engineering Conference and Exhibition, New York, NY. American Society of Mechanical Engineers, 345 E 47th St, New York, NY 10017. (212) 705-7795. August 9 to 13.

Advanced SMT Design Techniques (short course), San Jose, CA. Surface Mount Technology Plus, 2216 Lundy Ave, San Jose, CA 95134. (408) 943-0196. August 17 to 18.

Engineering and Manufacturing '87, Boston, MA. National Computer Graphics Association, 2722 Merrilee Dr, Suite 200, Fairfax, VA 22031. (703) 698-9600. August 17 to 20.

Designing Signal Processors with DSP and Bit-Slice Chips (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 1 to 4.

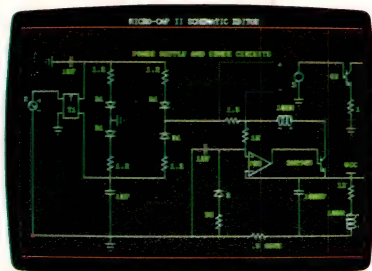


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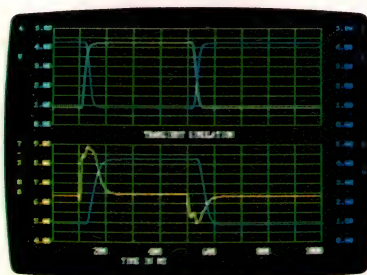
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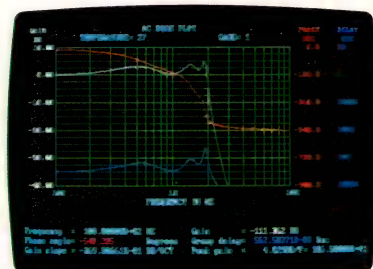
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Corning sleeve fits Microsemi diode like a glove

Microsemi Corp., a leading supplier of semiconductor products, says Corning's alkali-free glass sleeve is a major factor in developing high-quality, high-reliability diodes. Bert Brandt, Director of Procurement at Microsemi, explains:

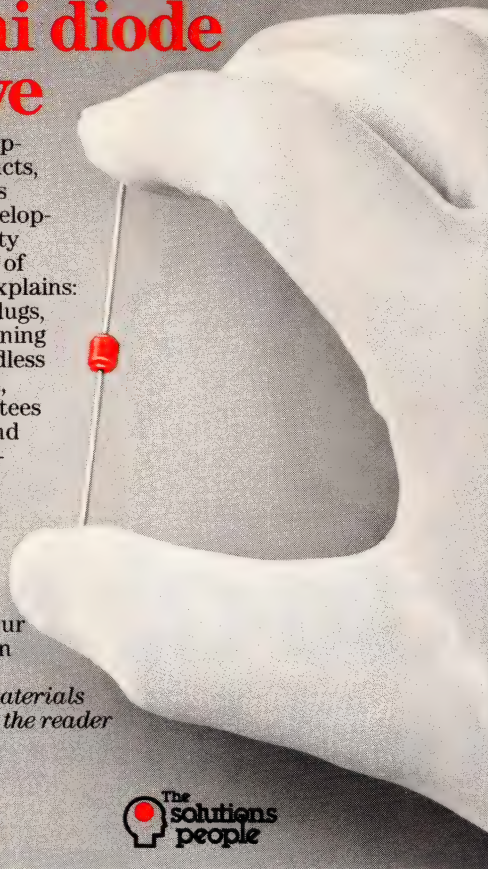
"After a chip is bonded to slugs, it's hermetically sealed in Corning alkali-free glass to form a voidless glass package. Corning's hard, chemically pure glass guarantees the chip won't be poisoned and withstands virtually any environmental stress. Up to 1400 volts per junction produce no evidence of arcing.

"Corning's quality and performance have made a major contribution to Microsemi's success. They've been our only supplier of encapsulation products for fifteen years."

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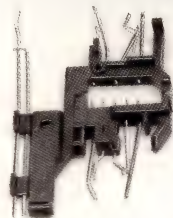


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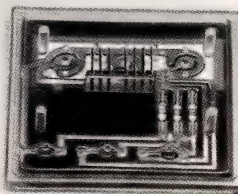
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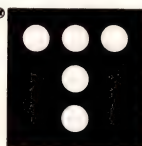


Complex insert moldings in any volume? This Tricon switch actuates a popular instant camera. Automated wire forming, precious metals plating, molding and process controls add up to value.



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CIRCLE NO 16

CALENDAR

Effective Skills for Technical Managers (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 1 to 4.

Modern Electronic Packaging, Seattle, WA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. September 9 to 11.

Invitational Computer Conference Computer Graphics Series, Fort Lauderdale, FL. B J Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. September 10.

Integrated Manufacturing Solutions (IMS '87), Long Beach, CA. Intertec Communications, 2472 Eastman Ave, Bldg 33-34, Ventura, CA 93003. (805) 658-0933. September 14 to 18.

PCB Expo, Minneapolis, MN. PMS Industries, 1790 Hembree Rd, Alpharetta, GA 30201. (404) 475-1818. September 15 to 17.

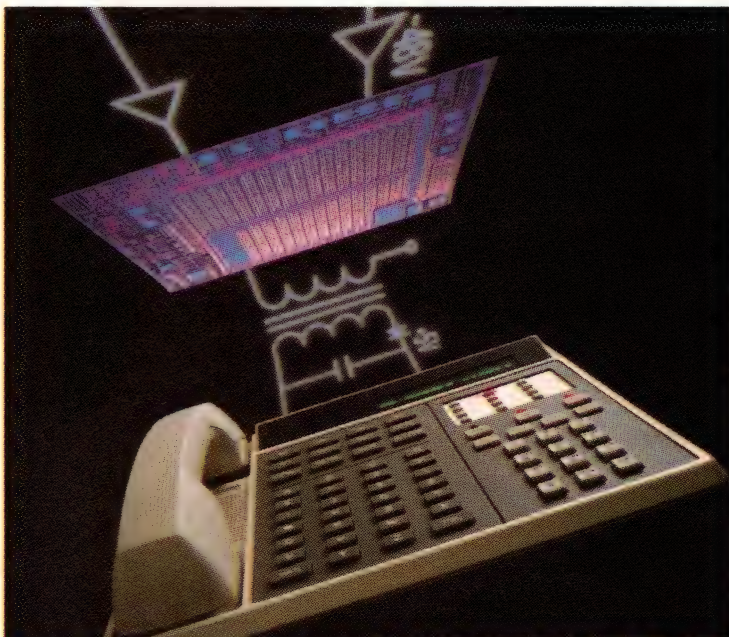
Effective Skills for Technical Managers (short course), Los Angeles, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 15 to 18.

Designing Signal Processors with DSP and Bit-Slice Chips (short course), Boston, MA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 22 to 25.

Canadian High Technology Show, Toronto, Canada. Canadian High Technology Week, 214-2487 Kaladar Ave, Ottawa, Ontario, Canada K1V 8B9. (613) 731-9850. September 28 to 30.

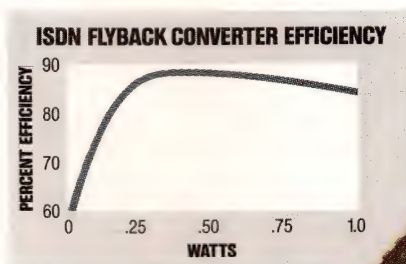
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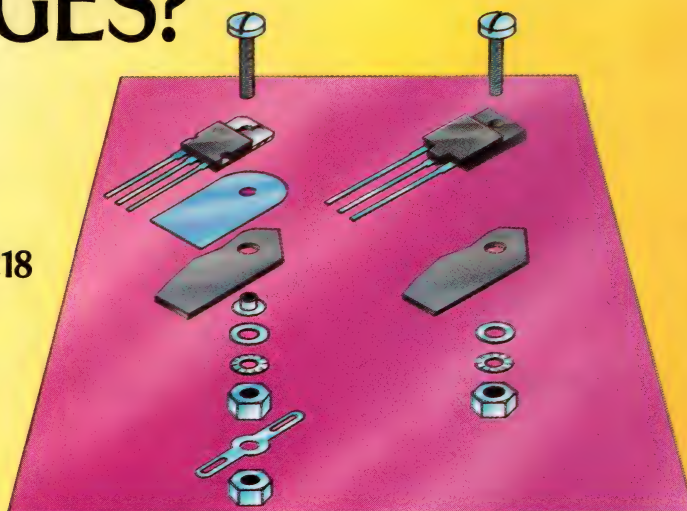
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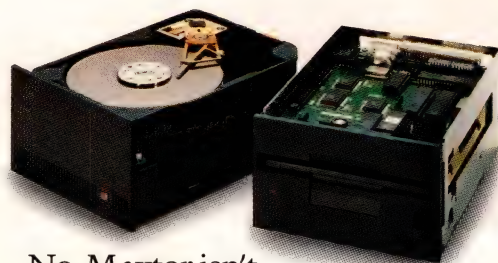
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EDITORIAL

PCs and MS-DOS won't die soon



Several people at the spring Comdex show in Atlanta told me they thought IBM's new PS/2 computer family would bring about the demise of today's personal computers (PCs) and disk operating system (DOS). Well, there's a lot of life left in most PCs and in Microsoft's Disk Operating System (MS-DOS). Obviously the people I spoke with had forgotten the erroneous predictions of rapid death for the CP/M operating system after IBM announced the original PC in 1981.

MS-DOS and MS-DOS-compatible software will be with us for many years. In fact, IBM renewed its commitment to MS-DOS compatibility by also announcing an operating system (DOS 3.3) that lets its new computers run existing MS-DOS-compatible software. Moreover, because IBM's new proprietary operating system (OS/2) won't be available until 1988, PS/2 owners must use DOS 3.3 now. They may never switch to OS/2 and the new software that goes with it. After all, many PC users still use early versions of MS-DOS effectively.

Also, many people will keep the computers they're used to rather than spend more money for new, single-sourced computer systems such as the PS/2. It isn't difficult to upgrade rather primitive PCs to sophisticated and powerful computers. For example, many companies offer accelerator boards that bring the power of advanced μ Ps such as the 80286 to older PCs. Likewise, manufacturers offer enhanced graphics controllers, expanded memory, and 32-bit μ P-based CPU boards that let computers tackle extremely complex tasks.

At Comdex, people also speculated that Unix would become the operating system of choice for PCs that incorporate 32-bit 80386 μ Ps. Thus, because 80386-based add-on cards are now available for PCs, Unix might become an alternative to MS-DOS in souped-up computers based on the 80386. However, for most general-purpose desktop-computing needs, PCs and MS-DOS remain favorites. They will remain so for many years.

Jon Titus
Editor

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What if there were a 16K Non-Volatile RAM that contained everything you needed in a single package? A fast and easy solution with everything from a long-life lithium battery to a real time quartz clock. Well, it's here. It's the Thomson-Mostek MK48T02 Timekeeper™ CMOS SRAM – another member in the ZEROPOWER™ family. This completely integrated device is far more efficient than real estate intensive discrete solutions. And in comparison to Dallas Semiconductor's DS1216, you'll find the 48T02 out on top every time. In every category.

For one thing, our Timekeeper RAM has 16K Bits of full CMOS memory. Theirs has none. Theirs often comes with the need for all kinds of support circuitry and discrete logic. Ours doesn't need any. And due to its software-controlled clock calibration, the Timekeeper RAM is ideal for high-accuracy applications. The Smart Watch is not. And the DS1216 requires extra time for serial-parallel software conversions and passwords. Our solution is completely parallel, so it doesn't waste your time.

The Thomson-Mostek Timekeeper RAM also features automatic power-fail chip detect and switching, write protection and read access and write times as fast as 120ns. Plus, it provides BCD format of clock and calendar data including the year, month, day, hour, minute and second. So you see, if an enhanced integrated memory solution is what you're after, don't just give it time, give it the Thomson-Mostek 48T02.

Timekeeper and ZEROPOWER are trademarks of Thomson Components-Mostek Corp. Smart Watch is a trademark of Dallas Semiconductor.

TIMEKEEPER™ VS. SMART WATCH™

The following chart provides a comparison of the Timekeeper to the closest level of integration available, the DSC Smart Watch. You'll be able to see that when it comes to comparing apples to apples, our Timekeeper RAM is much easier to use and much more cost effective.

Parameter	MK48T02	DS1216
Memory Provided	Yes, 2K x 8 Full CMOS	No, must be provided by user
Speeds Available	120ns to 250ns	250ns only
Data Access Method	Parallel	Serial
Time to Read or Set Clock / Calendar Data	2.25µs	32.25µs
On Chip Calibrations	Yes	No
Low Battery Warning Flag	Yes	No
Pins	24	28

CURRENT ZEROPOWER DEVICES

Write Control	Write Protection Voltage	
	4.75V	4.5V
2 or 3 Wire	48T02	48TI2
	48Z02	48ZI2
3 Wire only	48T03	48TI3
	48Z03	48ZI3

Also in development, we have higher density 8K x 8 ZEROPOWER RAMs to complement the family shown in the table below – the 48Z08, 48Z09 – both are 28 pin devices. Like our ZEROPOWER RAMs, these devices will be available with a 4.5V write protection option for use in systems with $\pm 10\%$ power supplies.

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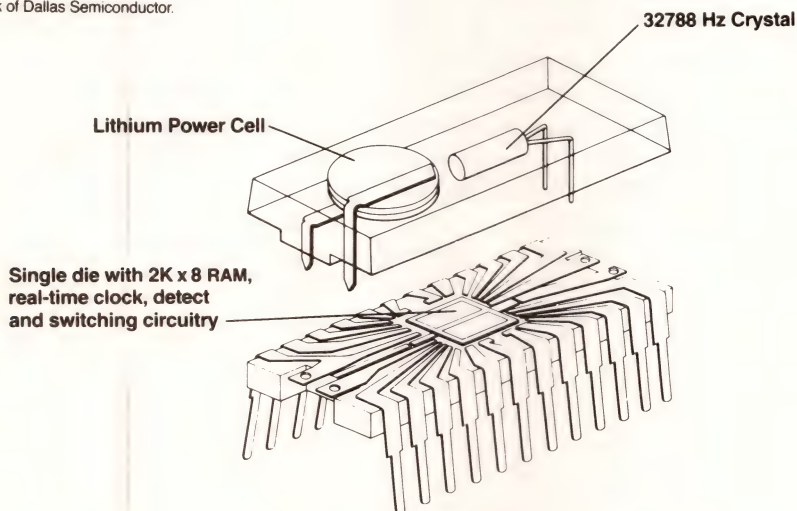
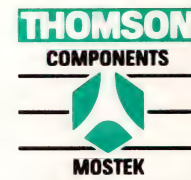
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Canada:

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514/288-4148
Brampton, Ontario
416/454-5252

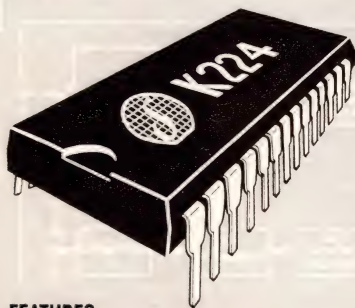
For all other countries:

Thomson
Semiconducteurs
43 Avenue de l'Europe
78140 Velizy –
Villacoublay, France
(1) 39 46 97 19



In addition to memories, Thomson-Mostek manufactures MOS and bipolar devices for both commercial and military applications: microcomponents, telecom/datacom and linear circuits as well as Discrete, RF and microwave transistors, passive components and ASIC.

**NEW
2400 BPS
CCITT V.22 BIS
SINGLE-CHIP MODEM**



FEATURES:

- One-chip multi-mode modem IC for V.22 bis/V.22/V.21 and Bell 212A/103 applications
- FSK (300 BPS), DPSK (600, 1200 BPS), or QAM (2400 BPS) encoding
- All modem functions included in a single chip
- Integrated DSP for high performance adaptive equalization receive capability
- Fully compatible with SSI K212, K221, and K222 1-chip modems
- Interfaces directly with standard microprocessors (8048, 80C51 typical)
- Single +12V or +5V supply
- CMOS technology for low power consumption (120mW @ 5V)

Silicon Systems now offers the industry's most highly integrated modem IC—the SSI K224. It is a single-chip modem IC that provides all the functions needed to construct a V.22 bis compatible modem, capable of 2400 BPS full-duplex operation over dial-up lines. The SSI K224 offers excellent performance and a high level of functional integration in a single 28 pin DIP. This device meets world-wide standards and supports all modes of operation, allowing both synchronous and asynchronous communication.

The SSI K224 is ideal for use in either free-standing or integral system modem products such as lap-tops, PC's and portable terminals, or wherever full-duplex 2400 BPS data communications over the 2-wire switched telephone network is desired.

The SSI K224 is pin and software compatible with the SSI K212, K221, and SSI K222 single-chip modem IC's, allowing system upgrades with a single component change.

For more information on the SSI K224 and the complete SSI K-Series modem IC family, contact: **Silicon Systems**, 14351 Myford Road, Tustin, CA 92680. Phone: (714) 731-7110, Ext. 575.

silicon systems
INNOVATORS IN INTEGRATION

CIRCLE NO 17

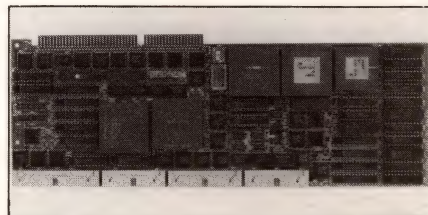
PRODUCT UPDATE

Coprocessor card adds high-speed computation to PC/AT

By combining Weitek's Exel 8000 microprogrammable μ P with Analog Devices' ADSP3221 and ADSP3210 floating-point multiplier and ALU on one card, the Trisonic 8 coprocessor board adds high-speed, floating-point computational capability to any IBM PC/AT or compatible computer that has one expansion slot and 3.6A to spare. The board incorporates three separate memory arrays: an 8k \times 32-bit instruction RAM, an 8k \times 32-bit data RAM, and a 2k \times 64-bit microcode RAM for the arithmetic pipeline.

The company offers two versions of the Trisonic 8: the -10 version and the -20 version. The -10 version, which is available now (delivery, eight weeks ARO), costs \$6995. It executes 10M instructions/sec through the onboard μ P and can perform 6.25M floating-point operations/sec with its arithmetic pipeline. The Exel 8000 μ P gives this board more capability than other vector-processing boards, because the μ P can run an application program independently of the host computer's 80286 CPU. The -20 version will have twice the speed of the -10 and will be available in October for \$9995. It will draw 6A from the host computer.

For maximum performance, the Trisonic 8 accommodates the Exel 8000's Harvard architecture by separating the instruction and data memories. Four expansion connectors, carrying separate 25-bit address and 32-bit data buses for the instruction and data RAM arrays, allow you to expand either or both of the onboard μ P's memories. The memory-expansion buses incorporate a wait-state interface that accommodates expansion memories of any speed (less expensive, slow



The 32-bit, microprogrammable μ P and the floating-point multiplier and ALU on this coprocessor board give an IBM PC/AT or compatible computer a big boost in computational speed.

memory simply degrades the board's performance). Microcode memory for the arithmetic pipeline cannot be expanded.

The coprocessor's arithmetic pipeline performs 32- and 64-bit floating-point calculations using the IEEE-754 format. The pipeline includes 32 32-bit registers, so it can efficiently perform array-based calculations for applications such as digital signal processing (DSP), FFTs, and matrix manipulation.

The company currently offers a \$2500 package of development software that includes an assembler for the μ P and a microcode meta-assembler for the arithmetic pipeline. C and Fortran compilers will be available in October at \$4000 each.

—Steven H Leibson

Zalea, 32915 Aurora Rd, Solon, OH 44139. Phone (216) 248-3934.

Circle No 613

"THEY SAID NO ONE COULD PUT IT ALL ON ONE CHIP."

Introducing the SSI K224 With Everything You Want in a 2400 BPS Modem— With DSP on Chip.

"When we set out to design the universal modem IC that would meet 300 to 2400 BPS worldwide standards, even some of our best customers were skeptical. We knew existing solutions took a handful of IC's and separate DSP's for V.22 bis operation, requiring a lot of space and power. Our customers said they needed a single IC that would do it all, so it was only natural that we would come up with a chip that would meet their needs.

"Here's what they asked for, and here's what the K224 gives them: V.22 bis, V.22, V.21, Bell 212A and 103 modes of operation for both synchronous and asynchronous communication; complete tone generation for DTMF, answer and guard tones; call progress tone and handshake pattern detectors; and all the other functions needed to support intelligent modem designs. We integrated all these functions plus the DSP on a single chip—something no one else had attempted.

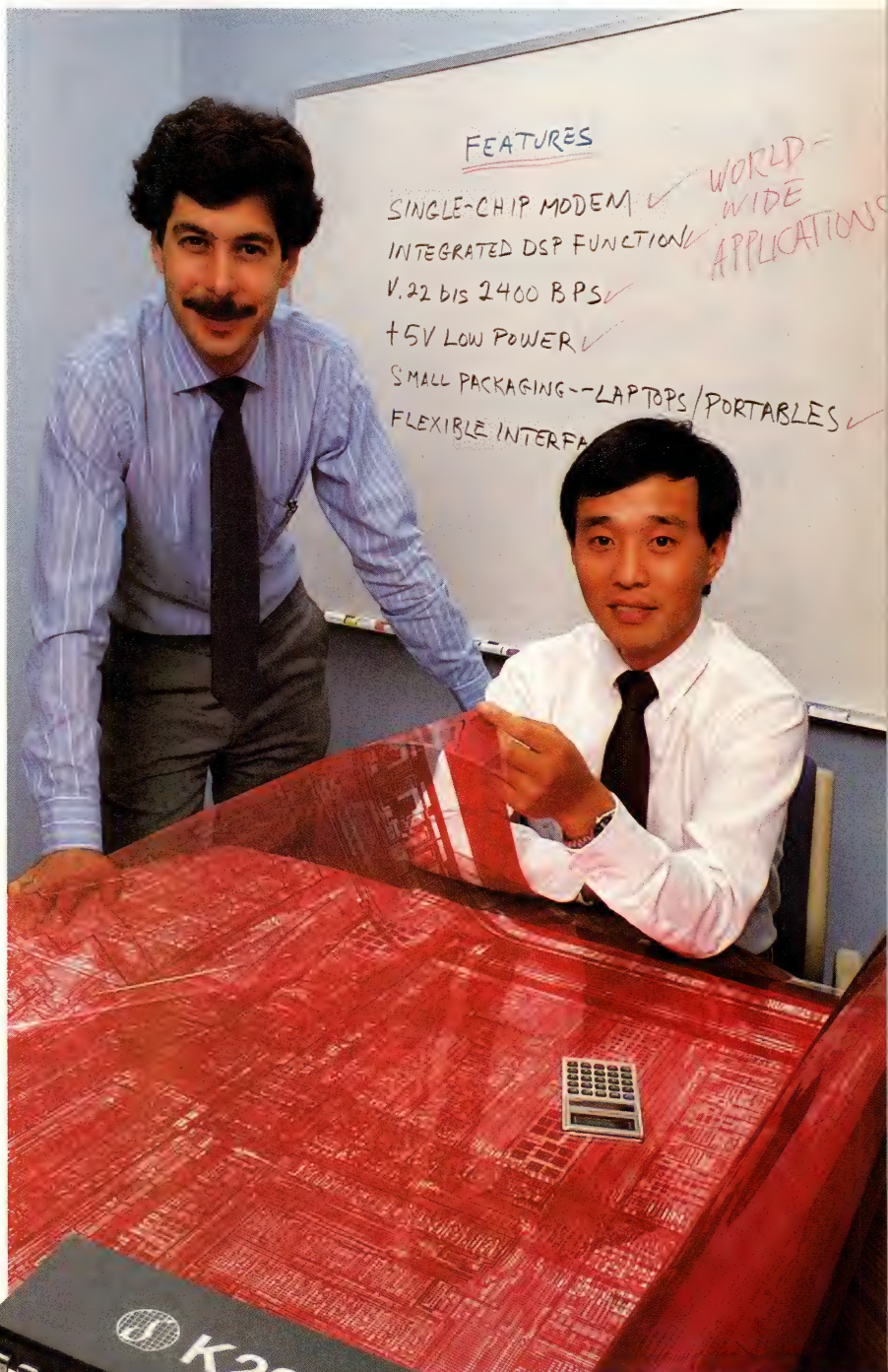
"So our skeptics were almost right when they said no one could put it all on one chip—because so far no one else has. Maybe some day someone else will. Meanwhile, give us a call and take advantage of the jump we've got on our competition by getting the jump on yours."

Call Now!

(714) 731-7110, Ext. 575

For more information on the SSI K224, or the complete K-Series family of compatible modem IC's, contact: **Silicon Systems**, 14351 Myford Road, Tustin, California 92680.

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Design Engineers

"Where we design to your applications."

He Just Spent \$175,000 NEEDLESSLY On A Competitive PCB CAD Software System

**You Can't
Make Those
Kinds of
Mistakes
and Survive
in Today's
Competitive
World...**



**...especially when he
could have owned
Bishop's PATHFINDER™
PCB CAD system from
anywhere from \$1,995
to \$7,990. And he would
have had, on an IBM
PC-based computer,
the same schematic
capture, layout and
autorouting capabilities
as the "mainframe-
based" software
system he bought.**

If you've been designing printed circuit boards or doing hand tape-ups during the last 22 years, then you know Bishop Graphics as the world leader in printed circuit design and engineering products. An interesting thing happens when you are effectively the only company selling PCB design products in over 72 countries in the world. You see, there is absolutely no company anywhere in the world that has the existing customer base that Bishop has. As a result, just about every CAD company or author has approached Bishop to either privately label their CAD package or distribute it for them.

Now why is that important to you, the engineer, designer or drafter? Simple! We've waited a long time to decide *which* CAD package we wanted to put our name on. We've looked at the advantages and disadvantages of the packages that have been brought to us and we've looked very hard at where the industry is going. The more we looked and compared, the more we realized that PATHFINDER was the way to go.

WHAT MAKES PATHFINDER DIFFERENT?

We know that the majority of the serious designers would like a fully integrated CAD system with an autorouter that can lay down as many as three traces between a DIP if they want. The problem is not a heck of a lot of people can afford to spend \$80,000 to \$200,000 for a CAD package. **It didn't take us long to realize that PATHFINDER's AutoRouter had the power and performance of the most expensive mainframe-based PCB CAD systems.** Nothing that we had evaluated, or that was brought to us (including most of the brand names that you know), could compare with the overall ability of PATHFINDER.

We've sold PCB design products to you for over 20 years and there's one thing that we know for certain...you're not interested in sales hype or fluff. **The problem that we're faced with, is how to convince you that it is foolish to spend \$1,000 on a "make do" CAD system and just as foolish to spend \$15,000, \$20,000, or even \$80,000 on a medium to high-end CAD system when you can get the performance of a \$90,000 plus CAD system at PATHFINDER's prices.**

LET'S TALK FACTS AND SPECIFICATIONS

PATHFINDER works in conjunction with, and uses the industry standard for 2D drafting... AutoCAD!™ You get a complete PCB and electro-mechanical 2D CAE workstation. You have full schematic drawing and capture, layout plus 32-bit autorouting. Not only can you create your own netlists, partslists, etc. but you can take an ASCII formatted list or document from another CAD system and format it so that PATHFINDER will read it. You've also got full IGES and Gerber I/O capability. PATHFINDER even allows you to "preview" your photoplot *before* sending it out to be plotted. You have generation of silkscreen and solder mask layers, drill drawings, assembly drawings, fabrication drawings, fast "on-the-fly" parts creation, 3D views, color or monochrome at any resolution, hardware pan and zoom, the use of a TTL, discrete and connector part library, stretching the layout, the latest concept of "what you see is what you get" (WYSIWYG), ratsnesting, drag and rubber-banding, semi-automatic heat sinks, keepout areas, top and bottom views for SMT with 3D views, and on and on.

MAINFRAME PERFORMANCE AUTOROUTING

The power and speed of a true 32-bit autorouter is what PATHFINDER's AutoRouter is all about. We supply you, along with the AutoRouting software, a parallel processor card that allows you to autoroute using 32-bit integer manipulations. We don't play any games when we talk about true 45° routing. You get it with PATHFINDER. None of this 90° routing and then go back and chamfer the corners to make it look like a 45° route was actually done. We know, and you know, that buys you absolutely no additional "real estate" on the board.

PATHFINDER also provides you with *real time Display While Routing*. What good does it do to come back *after* the autorouting has taken place only to discover that you wish you would have stopped it 5 minutes into the routing design to make a manual edit? Also, you'll be able to autoroute down to 6¼ mil trace widths...3 traces between a DIP pad.

Another thing we discovered is that even mediocre autorouters can achieve 100% completion rates if the parameters are sloppy enough. The real test of autorouting is not just speed, not just percent completion, but most importantly the *quality of design*. **You'll achieve the same kind of performance and completion rates that you would achieve on mainframe-based autorouters with PATHFINDER.** You can autoroute up to 16 layers. You have total access to the strategy parameters given you in the AutoRouter including rip-up and re-route when needed.

FREE TECHNICAL HOT-LINE SUPPORT

Whether you're doing analog, digital or SMT work, PATHFINDER allows you the ability to get the job done. It's easy to use and comes with a thorough, complete technical manual and tutorial. It is a fully integrated, intuitive CAD system expressed in terms that the PCB engineer, designer or drafter can appreciate. Bishop will provide free technical hot-line support during your first year of use.

NO-RISK GUARANTEE

We are so thoroughly convinced that PATHFINDER will become the de facto standard in the industry that we'll let you use it for 30 days and if it doesn't meet our published specifications, we'll refund your money with no questions asked. We suggest that you take a minute now to call our toll-free number, 800-222-5808* to get any of your questions answered that haven't, and can't, be answered in an ad. If you'd like to drop us a line, certainly do so, and mark your envelope "PATHFINDER."

**In Alaska, California, and Hawaii call (818) 991-2600.*

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Schematic Capture & Layout
\$1,995.00 (order #40000)

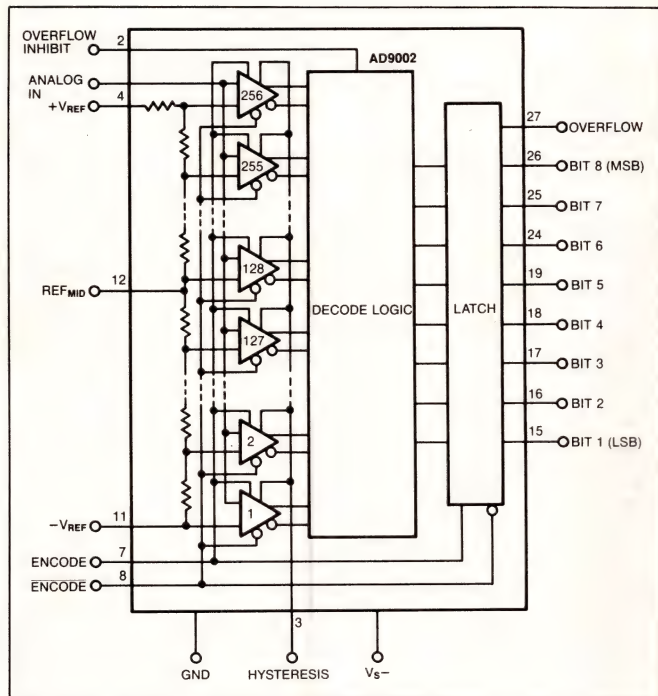
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"Standard" AutoRouter
\$2,995.00 (order #40020)



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CAD Systems Corporation
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Westlake Village, CA 91359
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Telex 66-2400 (BISHOP WVKV)
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READERS' CHOICE

Of all the new products covered in EDN's May 14, 1987, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our May 14, 1987, issue.

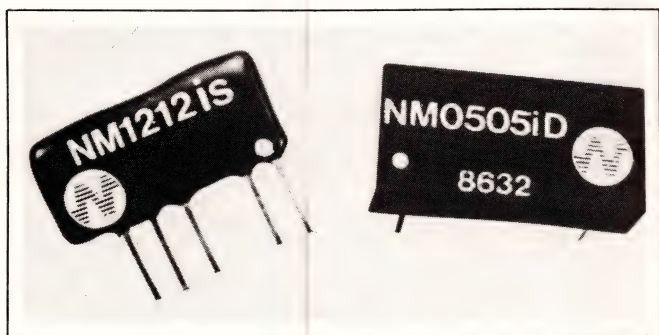


▲ FLASH A/D CONVERTER

The AD9002 flash A/D converter is fabricated in an advanced, high-density bipolar process and features a sampling rate of 150M samples/sec and a 3-dB analog bandwidth of 115 MHz (pg 111).

Analog Devices.

Circle No 540



▲ DC/DC CONVERTERS

The NM Series 0505i, 1212i, and 1515i dc/dc converters use state-of-the-art surface-mount technology to achieve power densities exceeding 11W/in³ (pg 266).

International Power Sources Inc.

Circle No 542

32-BIT μ C

The Macintosh II 32-bit computer that incorporates a 16-MHz Motorola 68020 μ P and a 68881 floating-point coprocessor chip in its standard configuration (pg 256).

Apple Computer Inc.

Circle No 541



▲ MOTION CONTROL

The Max software package, which runs on an IBM PC or compatible, lets you develop and test motion-control software for process-control systems that use ac-brushless or dc-servomotor technology (pg 288).

Ormec Systems Corp.

Circle No 543

50-GHz SCOPE

The PSP-1000 50-GHz sampling digital oscilloscope has a built-in liquid-helium cooling system for its superconducting circuitry (pg 298).

Hypres Inc.

Circle No 544

LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
TRANSFORMERS								
Toroidal	0	11	61	28	0	0	9.5	10.7
Pot-Core	0	13	67	20	0	0	8.8	11.4
Laminate (power)	5	24	62	9	0	0	7.1	9.6
CONNECTORS								
Military panel	8	8	34	50	0	0	10.7	13.3
Flat/Cable	10	45	35	10	0	0	5.7	5.9
Multipin circular	0	19	37	44	0	0	10.3	9.7
PC	17	33	39	11	0	0	5.8	6.5
RF/Coaxial	12	29	29	18	12	0	9.0	7.1
Socket	32	26	21	21	0	0	5.7	6.2
Terminal blocks	12	60	20	8	0	0	4.6	5.3
Edge card	6	35	47	12	0	0	6.6	9.2
Subminiature	15	25	35	20	0	5	8.2	6.3
Rack & panel	18	37	18	18	9	0	7.7	7.2
Power	20	20	20	40	0	0	8.4	11.1
PRINTED CIRCUIT BOARDS								
Single-sided	0	65	30	5	0	0	5.1	6.3
Double-sided	0	32	64	4	0	0	6.7	6.8
Multilayer	0	12	71	17	0	0	8.7	8.6
Prototype	4	83	9	4	0	0	3.8	4.8
RESISTORS								
Carbon film	55	19	13	13	0	0	3.6	4.6
Carbon composition	32	28	28	12	0	0	4.9	6.5
Metal film	33	37	19	11	0	0	4.3	5.5
Metal oxide	43	29	21	7	0	0	3.7	6.1
Wirewound	14	41	35	10	0	0	5.6	7.1
Potentiometers	14	33	30	20	3	0	7.4	7.4
Networks	16	37	37	10	0	0	5.7	7.3
FUSES								
	38	33	25	4	0	0	3.6	3.8
SWITCHES								
Pushbutton	21	42	29	8	0	0	4.9	7.3
Rotary	0	39	39	22	0	0	7.7	8.3
Rocker	10	45	25	20	0	0	6.5	6.1
Thumbwheel	0	39	46	15	0	0	7.2	8.4
Snap action	7	57	22	14	0	0	5.6	6.2
Momentary	21	47	16	16	0	0	5.1	7.2
Dual in-line	0	55	27	18	0	0	6.6	6.9
WIRE AND CABLE								
Coaxial	25	40	30	5	0	0	4.4	4.3
Flat ribbon	20	40	30	10	0	0	5.2	3.7
Multiconductor	13	44	30	13	0	0	5.8	6.2
Hookup	42	39	15	4	0	0	3.0	3.3
Wire wrap	41	35	12	12	0	0	3.8	4.3
Power cords	21	38	33	8	0	0	5.1	4.9
Other	11	56	11	22	0	0	6.0	10.8
POWER SUPPLIES								
Switching	0	24	53	23	0	0	8.6	12.5
Linear	14	22	50	14	0	0	6.9	9.3
CIRCUIT BREAKERS								
	11	44	28	17	0	0	6.1	5.0
HEAT SINKS								
	14	36	41	9	0	0	5.8	5.3

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
RELAYS								
General purpose	8	48	20	24	0	0	6.8	5.8
PC board	0	39	28	33	0	0	8.6	7.5
Dry reed	0	50	10	40	0	0	8.5	8.0
Mercury	0	37	27	27	9	0	9.8	8.3
Solid state	7	20	33	33	7	0	10.1	8.1
DISCRETE SEMICONDUCTORS								
Diode	30	27	28	15	0	0	5.3	5.7
Zener	27	33	23	17	0	0	5.5	5.8
Thyristor	0	43	28	29	0	0	8.0	8.5
Small signal transistor	17	50	6	27	0	0	6.3	6.7
FET, MOS	6	47	12	35	0	0	7.8	8.5
Power, bipolar	0	57	7	36	0	0	7.8	7.8
INTEGRATED CIRCUITS, DIGITAL								
CMOS	24	28	24	24	0	0	6.5	7.9
TTL	18	41	18	23	0	0	6.3	6.4
LS	23	36	18	23	0	0	6.1	6.1
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	0	58	17	25	0	0	7.0	8.7
OP amplifier	9	33	29	29	0	0	7.7	7.9
Voltage regulator	20	40	20	20	0	0	5.9	6.0
MEMORY CIRCUITS								
RAM 16k	23	31	8	38	0	0	7.5	7.1
RAM 64k	20	20	27	33	0	0	7.9	7.2
RAM 256k	12	38	25	25	0	0	7.0	6.3
ROM/PROM	21	14	29	36	0	0	8.3	6.6
EPROM	10	25	30	35	0	0	8.6	7.5
EEPROM	15	23	39	23	0	0	7.3	6.3
DISPLAYS								
Panel meters	13	53	20	14	0	0	5.3	8.2
Fluorescent	0	43	29	28	0	0	8.0	9.1
Incandescent	25	38	12	25	0	0	6.0	7.9
LED	22	30	30	15	0	3	6.7	7.4
Liquid crystal	0	21	22	50	0	7	12.3	9.1
MICROPROCESSOR ICs								
8-bit	6	31	25	38	0	0	8.8	9.0
16-bit	8	31	38	23	0	0	7.6	6.8
FUNCTION PACKAGES								
Amplifier	0	56	11	33	0	0	7.7	7.1
Converter, analog to digital	0	38	8	46	8	0	10.9	10.0
Converter, digital to analog	0	33	25	42	0	0	9.5	10.0
LINE FILTERS								
	0	45	22	33	0	0	8.3	8.5
CAPACITORS								
Ceramic	18	37	26	19	0	0	6.1	5.8
Ceramic monolithic	9	24	29	38	0	0	8.9	7.0
Ceramic disc	14	36	27	23	0	0	6.8	5.6
Film	4	46	18	32	0	0	7.8	9.8
Electrolytic	8	50	8	31	3	0	7.9	8.1
Tantalum	8	35	38	19	0	0	7.1	7.4
INDUCTORS								
	11	39	33	17	0	0	6.4	7.8

Source: Electronics Purchasing magazine's survey of buyers

For winning 8051 family designs that meet your time-to-market deadline and engineering budget—you'll need development tools, particularly In-Circuit Emulation.

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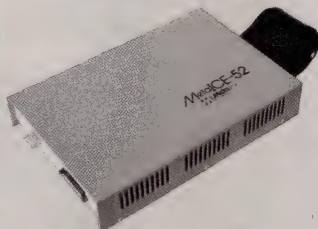
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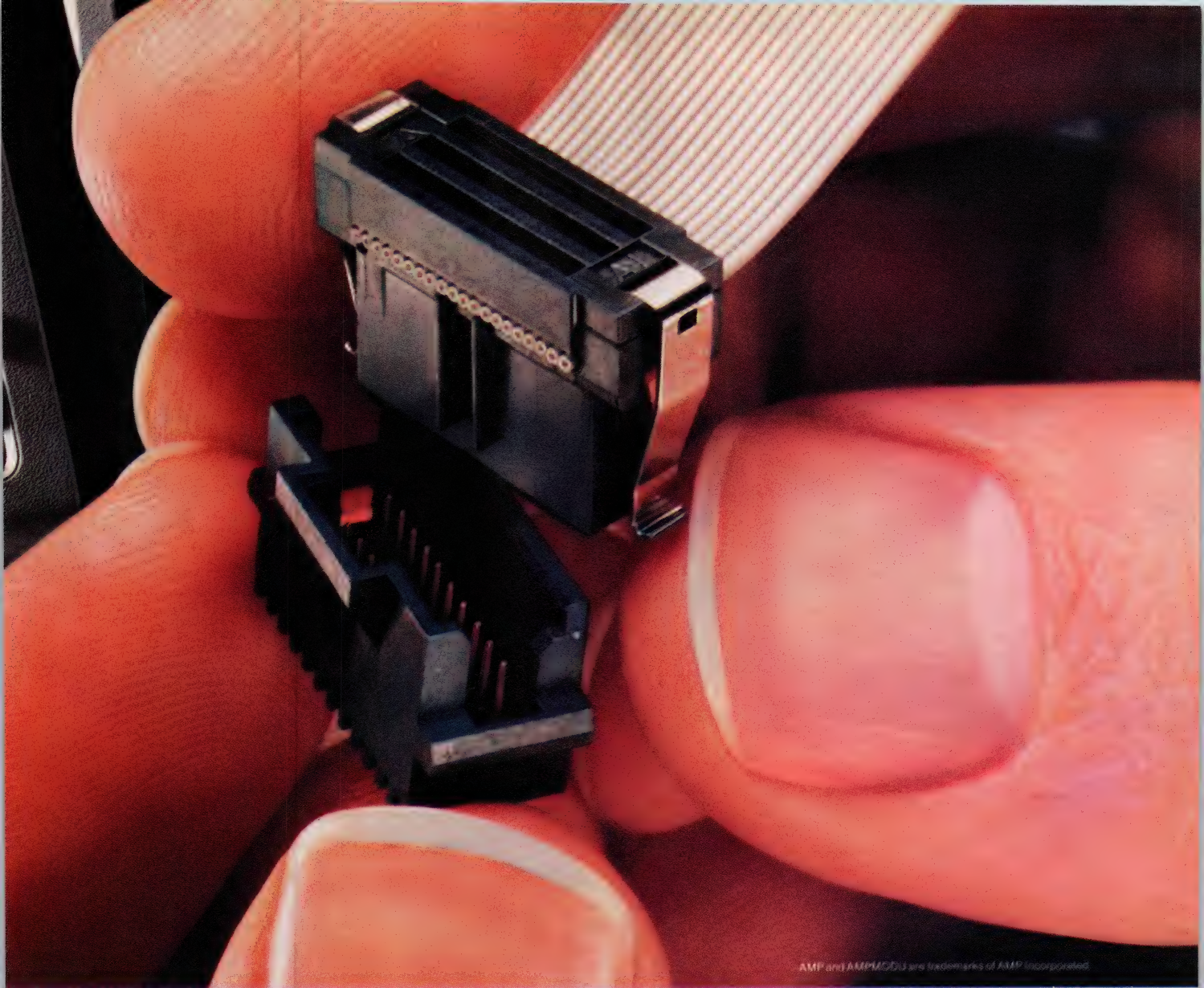


8051





**An idea this small
is no small idea.
Especially in a
system this big.**



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The AMPMODU System 50 connector family— a comprehensive interconnect system for .050 x .100 grid applications.

For board to board, mother/daughter or layered.

For flat flex cable and flex etched circuitry to board, on .050 centers.

For .025 center ribbon cable to board.

Unique design (such as connector latch hardware on the cable side) occupies the least pc board space of any connectors in this class, including .050 x .050

types. For instance: 2 x 25 position shrouded headers occupy 1.5 x .284 inches² of surface; parallel boards mate with inside faces a mere .450 inches apart.

Along with selection, you also get the productivity features you expect from AMP: simple mass termination, robotic handling features, high-temp housings, selective gold plating. And, of course, outstanding quality and reliability.

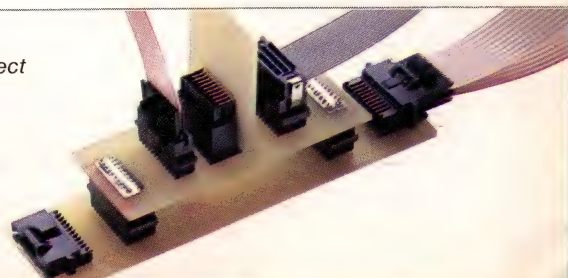
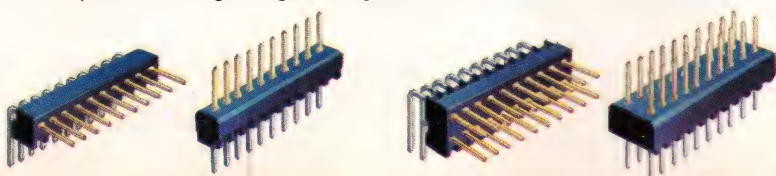
AMPMODU System 50

connectors are available in 4 through 30 positions in single row configuration, 8 through 100 in dual row, with shrouded or unshrouded headers. With all those variations, you could do almost anything your heart desires. Which is the whole idea. **Call the AMP Product Information Center at 1-800-522-6752 and ask about our AMPMODU System 50 line.** AMP Incorporated, Harrisburg, PA 17105-3608.

AMP Interconnecting ideas

CIRCLE NO 143

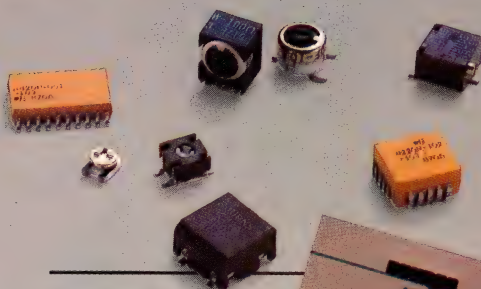
Comprehensive high-density interconnect system: .050 x .100 connectors in a range of styles, to meet a variety of needs including board-to-board interconnect in both parallel and right-angle configurations.



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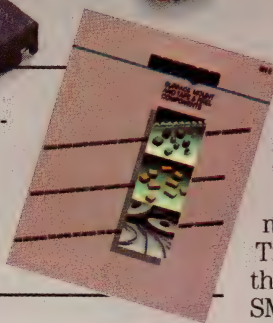
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Automated testing of SMT pc boards

When they came off the manufacturing line, our boards didn't work at all. To find out why, we handed them to ATE engineers, who built a test fixture, wrote and debugged a test program, and found the manufacturing defects on each board. The information they provided allowed us to repair the defects and eventually produce a working SMT assembly.

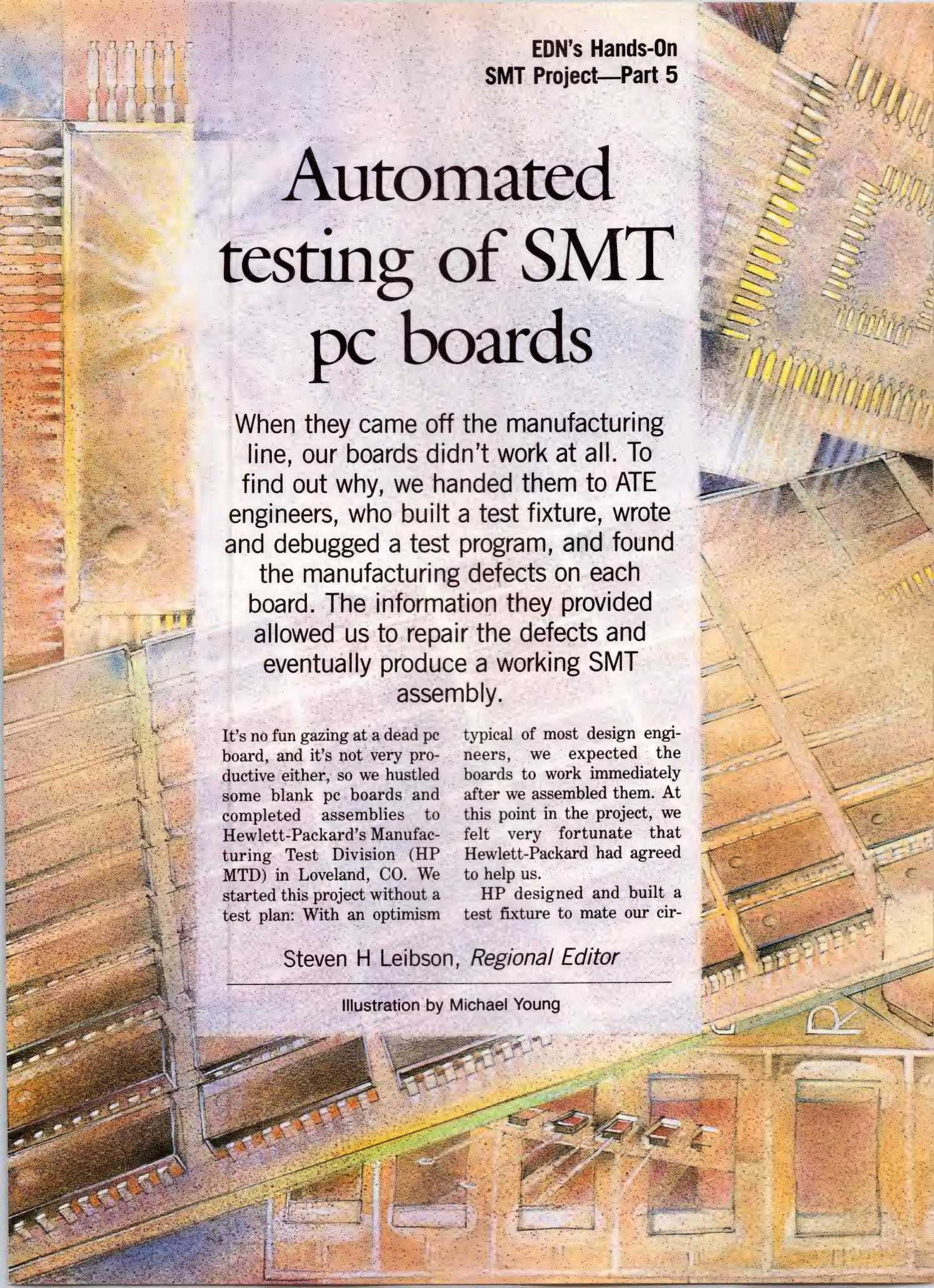
It's no fun gazing at a dead pc board, and it's not very productive either, so we hustled some blank pc boards and completed assemblies to Hewlett-Packard's Manufacturing Test Division (HP MTD) in Loveland, CO. We started this project without a test plan: With an optimism

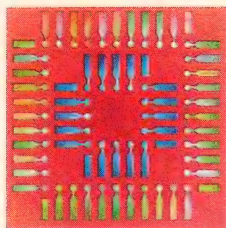
typical of most design engineers, we expected the boards to work immediately after we assembled them. At this point in the project, we felt very fortunate that Hewlett-Packard had agreed to help us.

HP designed and built a test fixture to mate our cir-

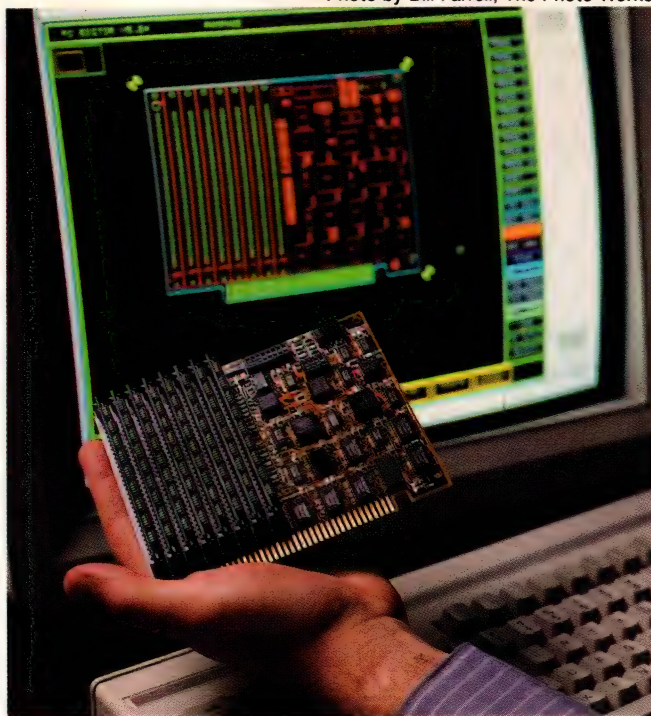
Steven H Leibson, *Regional Editor*

Illustration by Michael Young





Our finished assembly exactly matched the model we created using the Cadnetix workstation. In-circuit testing and a little rework to repair manufacturing defects produced a working circuit board.



cuit board to the company's HP3065 in-circuit, board-test system. A new product—the HP44203 Simplate test fixture—served as the starting point for our custom fixture. With the Simplate, tooling pins and test probes are mounted on only one plate, eliminating the tolerance accumulation of the more conventional 2-plate approach (see **box**, "Test fixtures for SMT Assemblies"). HP estimates that the fixture it built for EDN's project board cost \$2800 in time and materials.

MTD assessed our design and considers it to be very testable because every circuit node intersects at least one via that can be probed from the back of the pc board. In fact, the company uses our project board to show its customers how to design a testable SMT assembly. HP's Simplate test fixture accommodates both 100-mil and 50-mil test probes, but out of 192 testable nodes on the EDN SMT project board, only seven required the use of 50-mil probe pins. HP used 100-mil probes for the other 185 nodes. Although 50-mil pins are available for tight board designs, those probes cost more and fail more frequently than 100-mil probes.

Because we had not filled the vias on our board with solder during assembly, the test fixture's vacuum was not adequate to pull the pc board down onto the test probes. Air leaked through the open vias, reducing the suction. Had we foreseen this, we would have taken steps to fill the vias during the wave soldering of the memory sockets. HP solved this problem by building a plastic top cover for our test fixture.

A top cover gets in the way

The top cover incorporates adjustable push pins to press the pc board against the test probes. The cover also prevents contaminants from being sucked through the pc board's vias and into the test fixture by the vacuum. Although the electrically passive top cover costs far less than a cover containing probes for 2-sided probing, it still increases test costs directly through additional fixture complexity and indirectly through increased test cycle time. Each time a board is tested, the operator must open the cover, install the pc board on the fixture, close the cover, and

Test fixtures for SMT assemblies

Hewlett-Packard's Manufacturing Test Division (HP's MTD) took our SMT assembly, designed and built a custom test fixture for our pc board, and wrote the test that identified all of the manufacturing defects on our completed boards. MTD's application center used the company's new Simplate test fixture, designed for its HP3065 in-circuit board-test system, to test our board. HP specifically designed the Simplate for the tighter tolerances encountered in testing SMT assemblies.

Kris Jones, the product marketing engineer who supervised the fixture construction for us at MTD, says that, compared with 2-plate fixtures, the Simplate fixture provides five times better repeatability for contacting our small, 36-mil vias. She also asserts that if MTD had used a conventional 2-plate fixture, the lack of precision in the fixture could have caused as much as 9% of our assemblies to fail the in-circuit test because the fixture's probes would have failed to contact our small vias.

activate the test. In addition, the cover prevents an operator from activating the switches on the board during the test. For this reason, we did not thoroughly test the switches on the in-circuit tester.

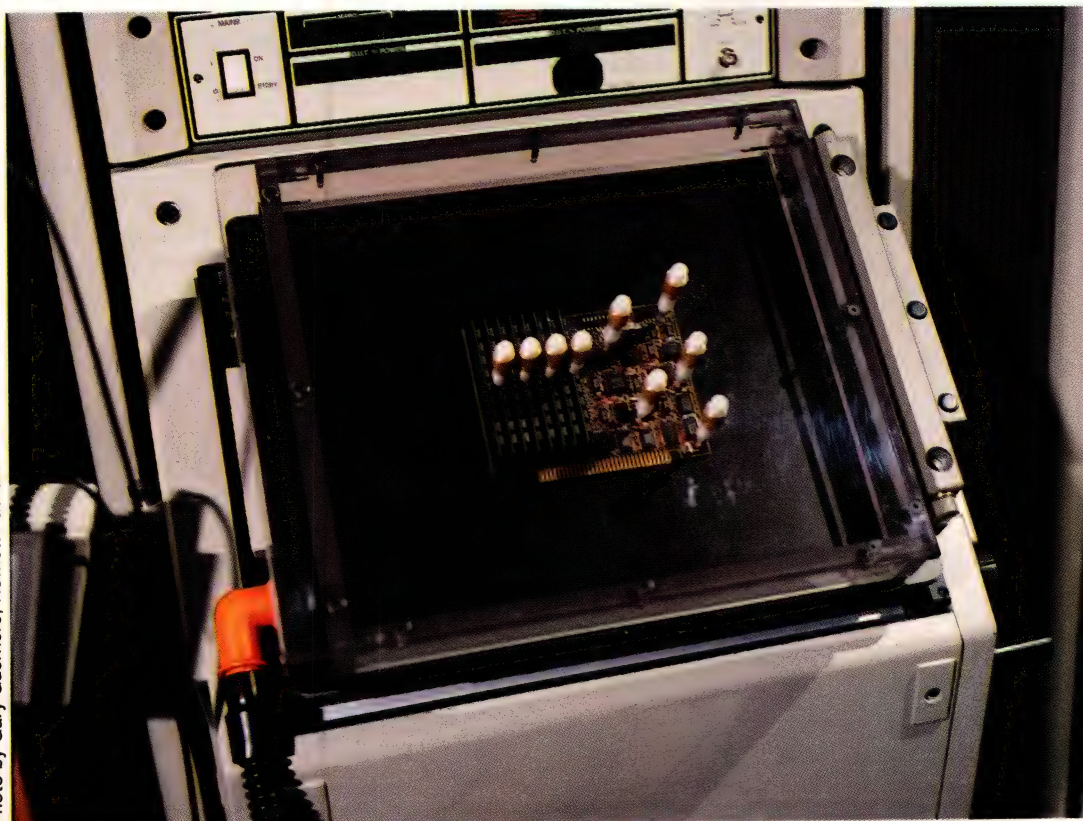
HP personnel determined the locations for the test probes on our fixture by "bomb-sighting" the vias on our pc board using an optical digitizer. This approach allowed the builders to create a fixture that matched the fabricated pc board rather than the theoretical model produced by the Cadnetix workstation. It was also easier for HP to manually digitize a fabricated pc board than to translate the pc-board design data from the Cadnetix workstation's format into HP's format. This phase represented yet another point during this project when people manually transferred information from one computer system to the next. We look forward to the day when a universal interchange format, like the developing EDIF standard, makes all of these manual transfers unnecessary.

The plate drilling and the wir-

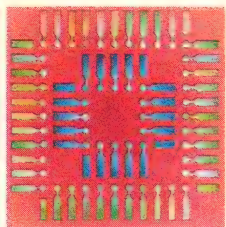
ing of the fixture required about one week. After the fixture was ready, HP's test engineers became involved with the project. Mitch Killmon and Jim Benson developed the test program for EDN's project board. The first step, transcribing the schematics, required about two and a half days. Note that once again the Cadnetix files weren't used: The test engineers effected the schematic transfer manually.

The HP3065's automatic test generator (ATG) took the first crack at creating a test program by using standard device models for most of the parts on our board. The PLDs and PROMs required custom models provided by HP MTD's application center. At this point, the two test engineers sat down to make the test work. Right off the bat, some of the tests created by the ATG required modification. Because the HP3065 tester overdrives IC outputs during some tests, the test engineers broke up long tests into several shorter tests to prevent the tester from damaging the components on our board.

We placed these engineers in an



Because we left the vias in our board unplugged, the in-circuit tester's vacuum system could not draw our board down onto the bed-of-nails test fixture. Therefore, Hewlett-Packard designed a top cover for the fixture that mechanically pushed the board onto the test probes.



unusual situation: We had no "golden" (known good) board. Test failures could be caused by the manufacturing defects on our boards, by bad components, or by an improper test. Without a golden board, the engineers had to consider all three possibilities. They took each failure on a case-by-case basis and found that failures caused by real defects were relatively easy to identify. The test ran completely after three days of debugging.

Of those three days, the test engineers spent an entire day chasing a problem with the dynamic-RAM test. The test indicated intermittent failures in the memory array, and the failures appeared to be position sensitive.



The two test engineers from Hewlett-Packard, Mitch Killmon (left) and Jim Benson, took the in-circuit board-test program created by the HP3065's automatic test generator and massaged it into a working test.

Ultimately, the culprit turned out to be the RAMs' need to be cycled eight times after powering up before they would operate properly. Adding a 1-line cycling routine at the beginning of the RAM test made all of the intermittent problems disappear.

The test engineers also noticed that the project board's power-to-ground capacitance jumped when they plugged the SIP memory modules into their sockets. Although not visible and not shown on the schematic, a bypass capacitor resides beneath each dynamic-RAM PLCC on the SIP memory module, so the pc board's bypass

capacitance more than triples when all eight modules are in place. The test engineers added a little more code to the test program to accommodate the extra bypass capacitance. HP estimates that the cost for creating this test was approximately \$5800.

When the test was ready, we brought all of the assemblies to HP for testing. The test quickly identified open connections, bad components, and wrong components. We then took these defective boards down to HP's rework area and repaired the manufacturing flaws. Then we took the assemblies back up to the tester and looked for more problems. By the end of the day, we had six boards that passed the test. We rushed these boards back to our office, plugged them into an IBM PC for a system test, and watched all of the boards once again fail to pass the computer's power-on self test.

This situation put us in a bad position. The HP3065 tester had blessed these boards. That meant that, as far as the ATE was concerned, the assemblies matched our schematic. We didn't know if we had incorrectly transcribed the schematic (although we and HP had triple checked our work), if we had caused a timing problem to appear through the use of SMDs (they're usually faster than equivalent through-hole parts), or if the documentation we had received from AST Research was wrong.

Sorry, wrong number

At this point we boxed two of the tested assemblies and copies of all of the engineering documentation we had generated and shipped the package off to AST. We soon had the answer to our problem. Both of the PROM listings we'd received from AST were wrong. They were down-level versions used on the prototype Ram-page! board and didn't match the production version of the circuit design that we had used. AST sent us new PROM listings to

solve the predicament.

Next, we needed to program some new PROMs, but of course we had used up our entire stock of devices to assemble our boards. Once again, we were gently reminded to always acquire three times more prototyping stock than we think we'll need. We made some phone calls and received the required parts in a couple of weeks. Then we visited Cadnetix to borrow the company's device programmer once again, and we burned the new codes into the PROMs. We journeyed back to HP MTD, where a repair technician carefully removed the old PROMs and soldered the freshly programmed parts onto the boards.

Avoid rework like the plague

Each PLCC PROM package required about 15 minutes to replace, using some fairly sophisticated rework equipment. We were struck by the slowness of the repair procedure and recalled all of the times during this project that one expert or another had told us to get our process right the first time. Rework on an SMT board is costly in terms of time, personnel, and equipment. You don't have to watch too many of these SMT repair jobs to realize the importance of making sure, in every possible way, that your board is optimized for manufacturability. Although the 10 pc boards in our prototype run had several manufacturing flaws, we feel that we understand the causes of those defects and could avoid them in a production environment because of the experience gained during this project.

With the new components installed, we placed the boards back on the HP3065 tester and verified the repairs. Then, we returned to our office and attempted to run the refurbished boards in our PC. Once again it was no dice. Another call to AST gained us one more piece of information: We still didn't have the production PROM codes on our boards. AST had

written new PROM codes for us, trying to compensate for perceived differences between AST's schematic and ours.

Success at long last

At this point, AST asked that we send the boards to them and took responsibility for making our assemblies work. We gladly shipped the company two more assembled pc boards. It turned out that the new PROMs required some nonstandard switch settings. With those settings, our boards completed all system tests with flying colors and ran like the Rampage! clones they were supposed to be. We had achieved our goal: We had produced a working, SMT version of a through-hole product.

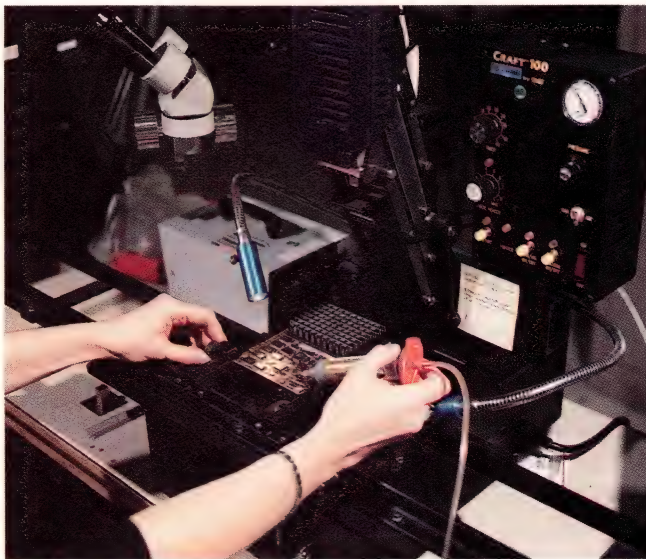
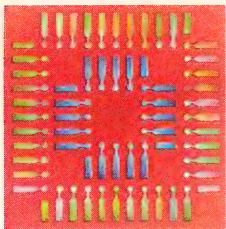


Photo by Gary Guerriero, Hewlett-Packard

Even with the proper equipment, rework and repair of SMT boards require substantial amounts of time. We spent about two hours replacing two PLCCs on each of eight circuit boards at Hewlett-Packard's Manufacturing Test Division.

In the conversion process, we reduced the Rampage! board's size by approximately 60%. The SIMMs allowed us to shrink the real-estate consumption of the memory array on the board by 74%. Although more exotic SMT techniques like placing components on both sides of the board would have allowed us to further reduce the size of our board, we achieved our goal of creating a board that fit into a PC's short slot without resorting to such higher-cost approaches.

Since we completed the construction of the project board, many of the people who helped us



on the project have had a chance to evaluate the finished product and the worthiness of our design. We did a lot of things right. The training we received at the beginning of the project paid off well. The EDN SMT project board has the two characteristics we strived to attain: manufacturability and testability.

We did not do everything right, however. John Maxwell at AVX (Colorado Springs, CO) attributed the resistor tombstoning we encountered to the presence of solder mask under the components. He pointed out that even though our pc board was quite flat, its solder plating (applied to the board during pc-board fabrication by the hot-air leveling process) became molten during the reflow-soldering operation. At that point, the seam between the pad and the solder mask was no longer flat; it became a step. The edge of the solder-mask layer acted like a fulcrum as the surface tension of the molten solder hoisted the ends of the resistors off the board, creating the tombstoned devices. Elimination of the solder mask from beneath passive components would reduce this problem, something we learned in our training but didn't fully appreciate until we experienced the problem firsthand.

Over the course of this project we learned not to be so fanatical about requiring that every com-

ponent be an SMD. Ultimately, we used through-hole SIMM sockets, which forced us to add a wave-soldering step to our manufacturing process. Once we added wave soldering—and thus incurred its additional cost—we could have used even more through-hole components.

In particular, we feel that the pin header we used on our project board should have been a through-hole component. As an SMD, the header uses more pc-board real estate than the equivalent through-hole part, and its basic design, with pins growing out of the top, gives vacuum-pick-up placement machines difficulties—it's like trying to pick up a porcupine with a vacuum-cleaner hose. That's why we placed the components on our boards by hand during our prototype run.

One experiment we'd perform before putting this product into production would be to build a few more boards with the LSTTL logic replaced by functionally equivalent, advanced CMOS SMDs. Although the memory section of the board runs cool to the touch, the control section becomes quite toasty. This situation emphasizes the extreme component density SMT allows you to obtain. Many engineers have developed an intuitive sense for the number of through-hole components they can cram onto a board without creating heat problems.

The through-hole Rampage! memory card from AST Research (rear) dwarfs EDN's SMT project board, but both boards have equivalent capabilities and memory capacity.

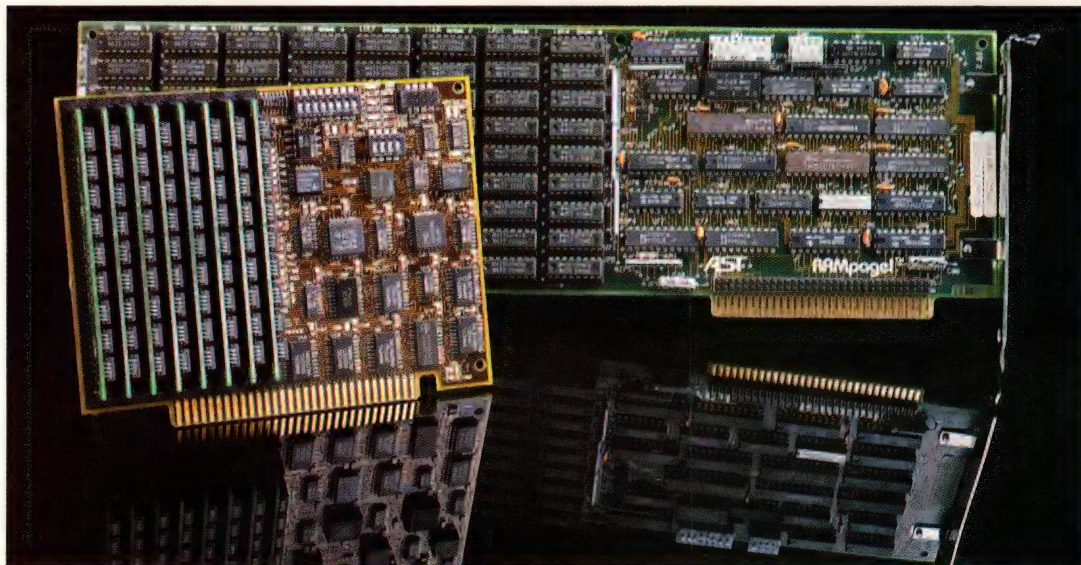


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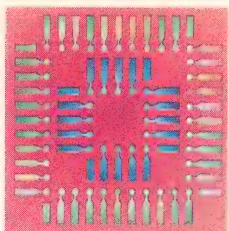
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SMT invalidates that intuition and increases the need for thermal simulation.

Goodbye to tradition

Seat-of-the-pants thermal management isn't the only tradition SMT crumbles. SMDs' small size and faster speeds put wire-wrapped breadboards on the road to extinction because device manufacturers do not design SMDs to be socketed. Socketing goes against the SMT philosophy of smaller and less expensive and introduces extra impedance that can slow or distort the high-speed signals SMDs can produce. If you start designing SMT assemblies, you should become accustomed to the idea of pc boards as breadboards. That's the only type of assembly that will give you a true picture of your design's performance.

We find the increasing availability of analog and digital simulation software on CAE workstations quite opportune because it coincides nicely with SMT's growing popularity. With a pc board serving as your breadboard for SMT assemblies, you'll want to simulate the circuits on your board to give you confidence in your design before committing it to fabrication, because SMT pc boards are tough to patch. Cutting and jumping circuit traces to fix design errors in a prototype circuit board doesn't work very well in SMT's world of fine-line circuit-board traces and small component lead pitches.

As more designers turn to SMT to create products, we foresee the need for closely linked CAE work-

stations, prototype and production placement machines, fixturing equipment, and board-test ATE. Few engineers will tolerate the constant manual transfer of design information from one computer-based system to the next that seems to be the norm today. As we discovered during this project, manual information transfer between computerized systems lessens both speed and accuracy. We see this situation as quite an opportunity for a large company or group of companies to wrap the entire SMT-assembly development process, from design to manufacture, into one neat package.

For most companies, SMT isn't an end unto itself; the technology is simply a tool for you to put into your toolbox along with data books, soldering irons, standard logic parts, ASICs, and μ Ps. Even though SMT is more than 20 years old, wide-scale use awaits further refinements in components, design tools, and assembly automation that will make the technology a truly universal engineering tool. As with any engineering tool, the trick is to know when, and when not, to use it.

EDN

Acknowledgment

Many, many people contributed to the success of EDN's SMT project. We appreciate all their contributions. A few people made outstanding contributions. We especially thank Art Lindsay and the CAD instructors at Cadnetix, John Maxwell at AVX, Dr Charles Hutchins at Texas Instruments, and Mitch Killmon at Hewlett-Packard.

No matter how many machines and systems an engineer has for aids, people still make the difference between the success and failure of a project.

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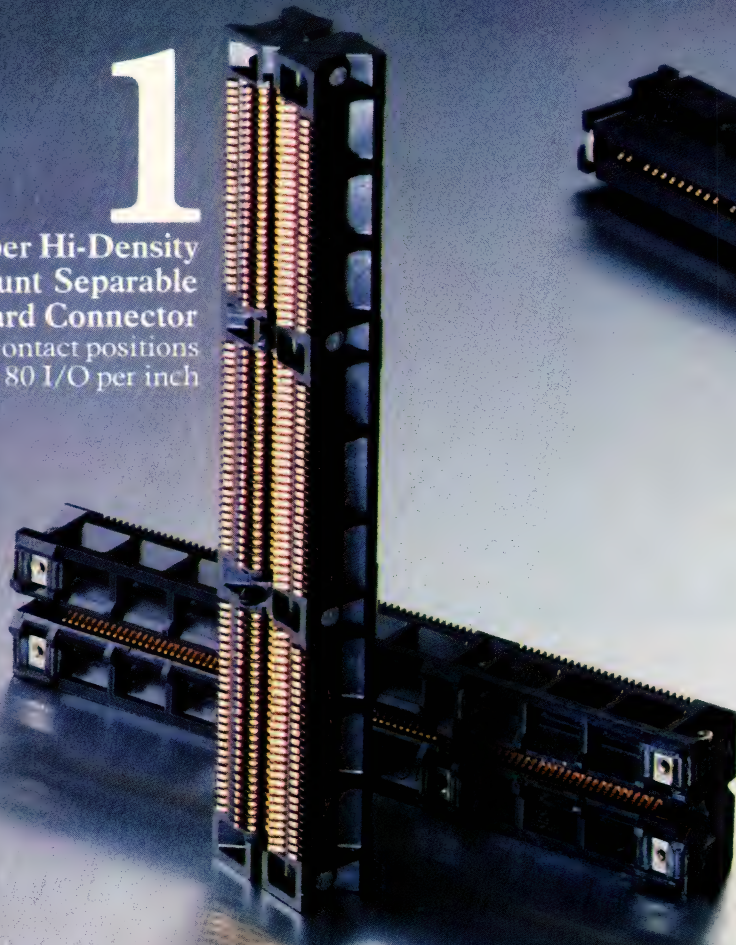
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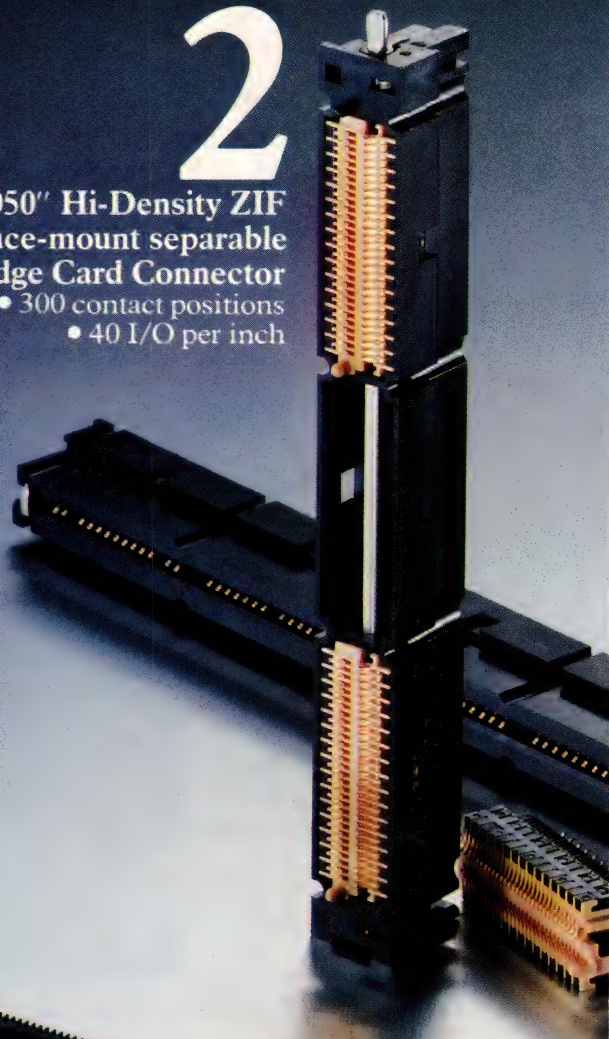
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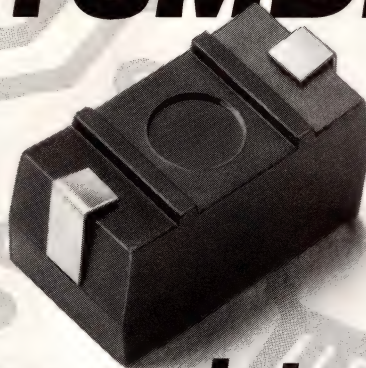
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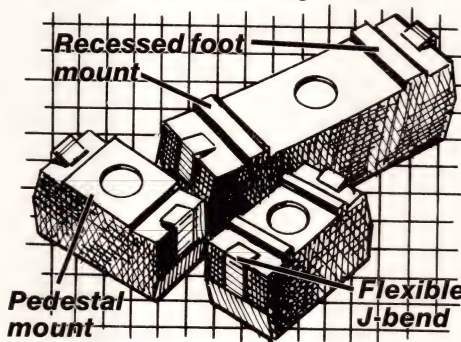
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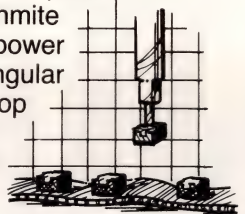
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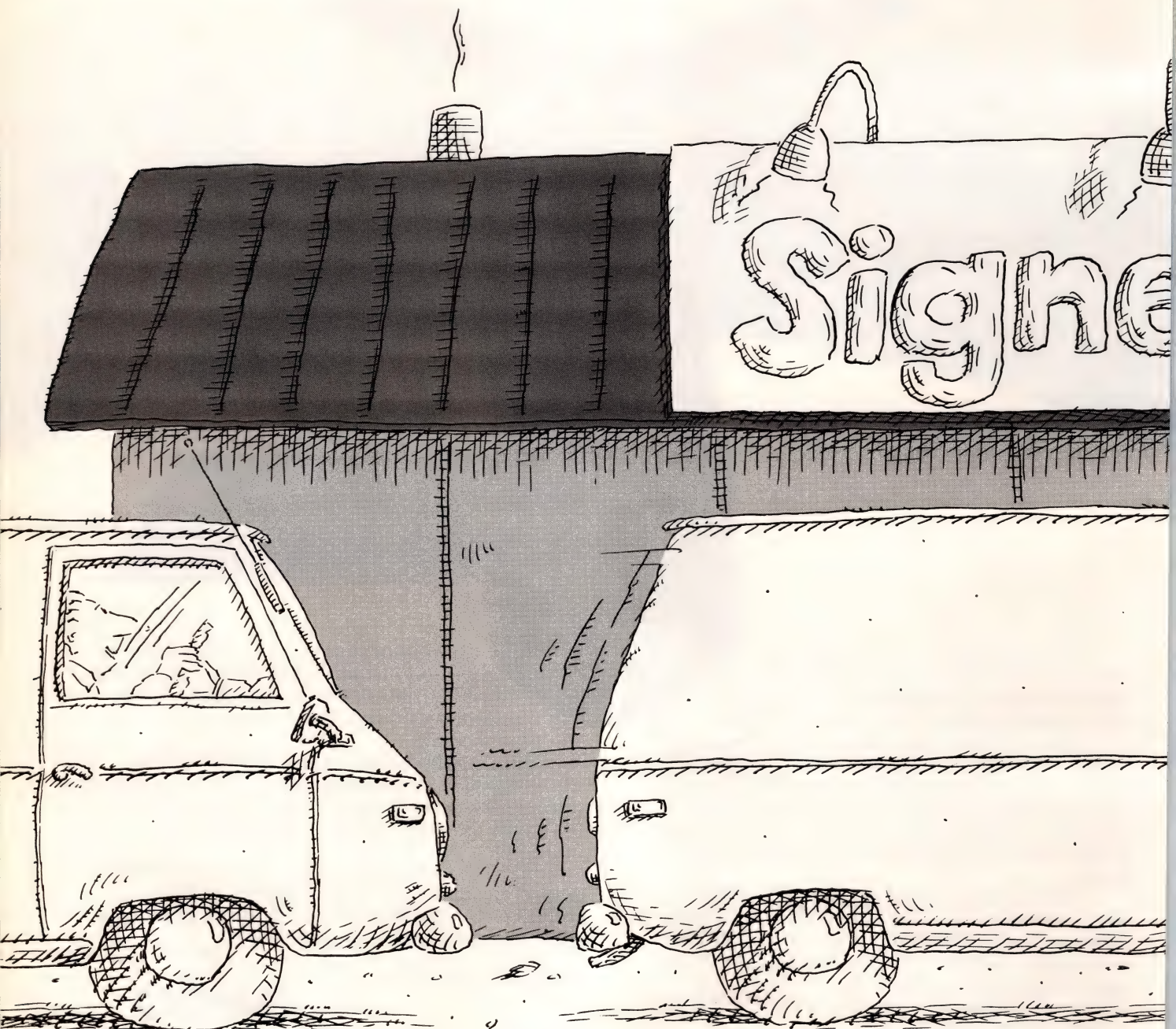
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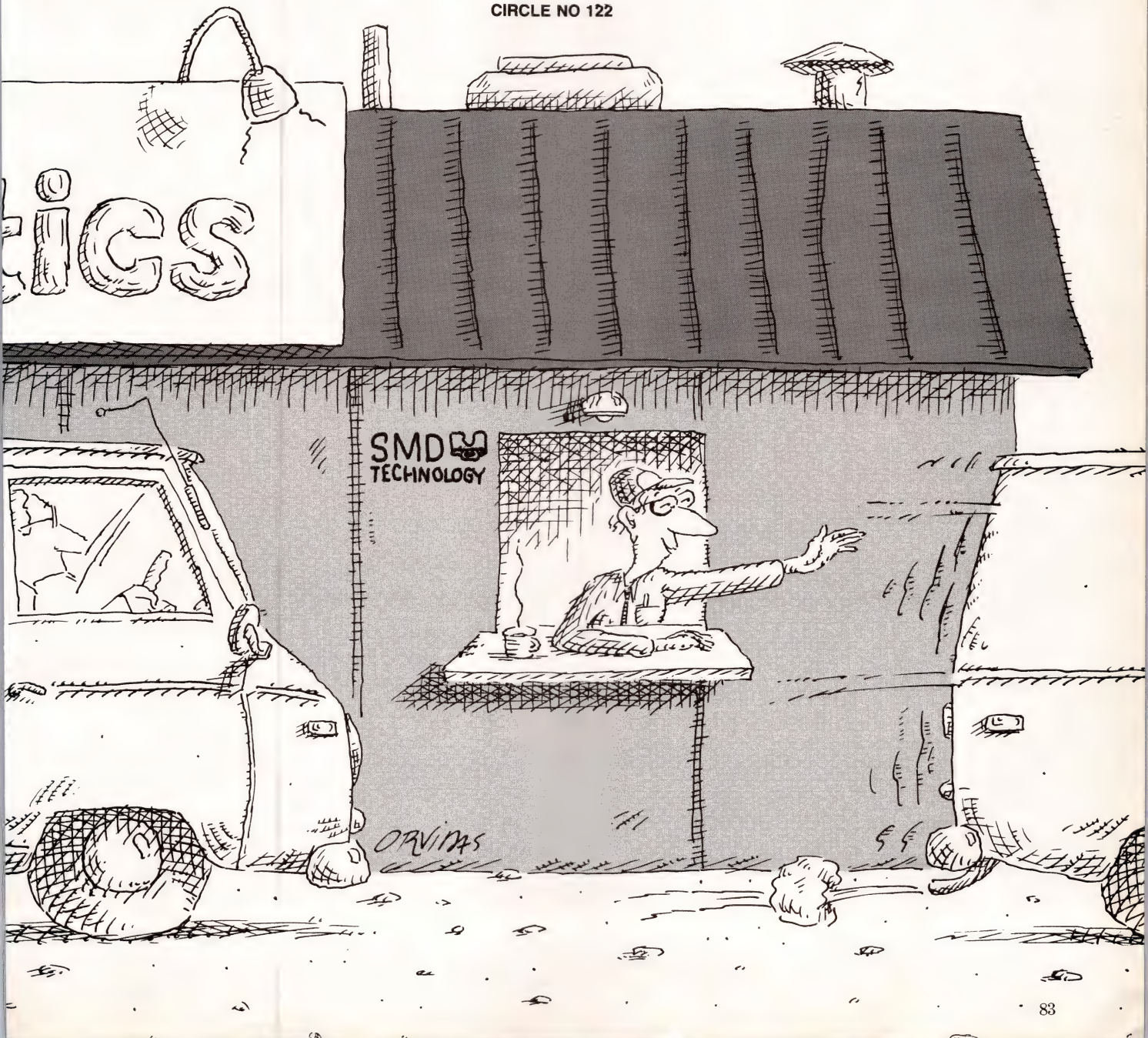
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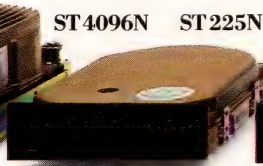
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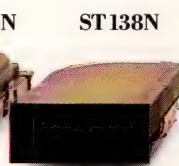
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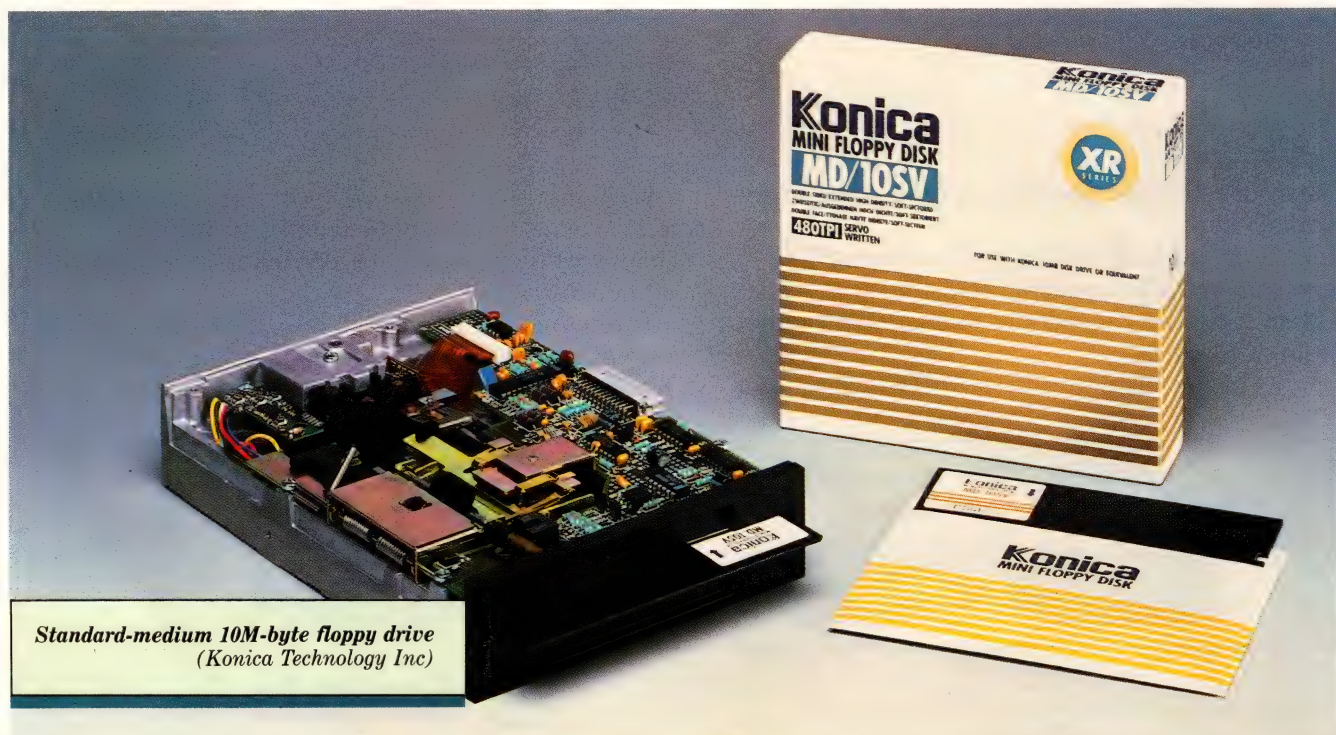
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Floppy-disk drives store 3M to 20M bytes in niche applications

Disk drives that use removable flexible media now reliably offer formatted capacities as high as 20M bytes. However, several factors—including high drive and media costs, interfacing difficulty, and lack of standardization—have combined to limit the high-capacity drives' use.

Maury Wright, *Regional Editor*

A high-capacity floppy-disk drive might be the best form of either primary or backup storage for your next computer design project or purchase. Such drives reliably store 3M to 20M bytes, formatted, and some even offer performance comparable to Winchester's. But beware: The drives or the nonstandard media that the drives require might be prohibitively costly for your project. Furthermore, no two manufacturers offer



Standard-medium 10M-byte floppy drive
(Konica Technology Inc.)



*Hard-shelled 10M-byte drive
(Data Technology Corp)*

High-capacity floppy drives may fit your needs for primary or secondary storage, but the lack of drive and medium standards limits sources and increases cost.

compatible products, and the drives might lock you into an interface that wasn't part of your design plans.

In fact, such issues have hampered every manufacturer who has tried to build and market a high-capacity floppy-disk drive. Several of these companies have gone out of business, and others have met with moderate success at best. Despite the shaky past, a handful of companies now markets the drives, and several more have designs on the drawing board.

Drives suit archival applications

Manufacturers of high-capacity floppy-disk drives aim their products at a variety of applications. For example, the floppy products discussed in this article provide an attractive alternative to tape drives in a Winchester backup role. The random-access floppy drives allow users easier, faster, and more efficient access to stored data than do tape drives.

The floppy drives and media, however, cost more than the tape alternative. You might also find tape to be more convenient because even low-end tape cartridges now store 40M bytes. Tape drives therefore allow you to back up larger fixed disks on one cartridge than do the high-capacity floppy drives.

Manufacturers also believe high-capacity floppy drives can serve data- and software-distribution applications. Now, either standard floppy-disk or tape media serve such distribution tasks. High-capacity floppy media provide speed and convenience advantages in distribution applications. Because there is no high-capacity floppy-disk standard, however, the drives primarily fit only captive computer uses for distribution. For example, if you build and sell proprietary computers, you can include a high-capacity floppy drive on each system and subsequently distribute data or software on the floppy media.

Data distribution fits noncomputer uses

Michael Sugihara, director of strategic planning at Data Technology, claims data-distribution applications extend past computer systems. Data Technology offers the TakeTen 5¼-in. half-height drive, which stores 10M bytes on a cartridge. Sugihara believes products such as a digital PBX can make use of the TakeTen. Manufacturers and users of such PBXs can use the floppy drive to distribute and load new software for their products.

Despite these potential applications, Phil Devin, senior industry analyst at the San Jose, CA, market-research firm Dataquest, points out that to date most



Dual 20M-byte drive (Iomega Corp)

high-capacity floppy drives have been sold for primary-storage applications. According to Devin, Iomega has sold more high-capacity drives than any company, and most of Iomega's sales have been into primary-storage applications.

Iomega's initial product, the Alpha 10, featured 10M bytes of capacity in a full-height 8-in. form factor. The company now offers the Alpha 10 and the 20M-byte Alpha 20 in half-height 8-in. packages. Most of Iomega's sales of the Alpha drive have been as external add-ons for personal computers. Retail prices to end users for such add-ons are \$1295 for the Alpha 10 and \$1795 for the Alpha 20. Dual-drive versions cost \$1995 and \$2595, respectively, and to use the drives with an IBM-compatible personal computer, you need a host adapter that can cost from \$200 to \$280.

Half-height 5¼-in. drive stores 20M bytes

You can buy the Alpha 10 or Alpha 20 for use in OEM designs also. The products cost \$605 and \$755 (10,000), respectively. Late last year Iomega began shipping a half-height, 20M-byte, 5¼-in. drive, called the Beta 20, which has also met with limited success as primary storage for IBM-compatible personal computers. Iomega has primarily targeted the Beta 20 for direct sales to OEM computer manufacturers, although systems houses will certainly offer them as personal-computer add-ins and add-ons.

Iomega is the only high-capacity floppy manufacturer that has managed to sell its product to large personal-

computer-industry OEM customers. Data-storage subsystem manufacturer Mountain Computer has integrated the Beta 20 into its personal-computer add-on family, and Tandy and Leading Edge offer it as a storage option on personal computers. For OEM customers, the Beta 20 sells for \$500 (10,000).

Iomega was also the first high-capacity floppy-disk-drive manufacturer to offer an interface that was truly suitable for such products. All of the company's products include a SCSI (Small Computer System Interface) controller embedded on the drive. Because of the intelligence inherent in the SCSI interface, designers can develop software suited to the unique characteristics of data-storage products that use removable media.

SCSI meets drive requirements

For example, standard-floppy interfaces don't offer the data-transfer rate required for high-capacity products. And other interfaces don't include provisions for handling the unexpected removal of media or for handling write-protected media. A few manufacturers of removable-floppy and -Winchester drives have attempted to use the ST-506/412 interface that was developed for fixed-medium Winchesters. In such cases, removal of the media during file-write operations can cause data loss due to write faults. Programmers can write operating-system drivers that gracefully recover from write faults on SCSI-based peripherals.

Kodak has had limited success marketing two floppy-disk drive models that store 3.3M and 6.6M bytes, unformatted (2.5M and 5M bytes, formatted). Kodak licensed marketing and manufacturing rights to the

drive technology from now defunct Drivetec, which was based in Los Gatos, CA. Kodak offers the Kodak 3.3 and Kodak 6.6 as OEM products for \$460 and \$540, respectively. Personal-computer users can purchase the 6.6M-byte product as an add-in for \$795. The drives, however, employ a proprietary interface that has hampered their success.

On its newest floppy-disk drive, Kodak offers an embedded-SCSI controller. The Kodak 12 costs \$1200 as an OEM product and \$1499 as a personal-computer add-in, and it stores 10M bytes, formatted. The 10M-byte product's drive technology was jointly developed by Kodak and Data Technology, whose TakeTen costs \$1085 as a personal-computer add-in or approximately \$500 (1000) for OEM customers.

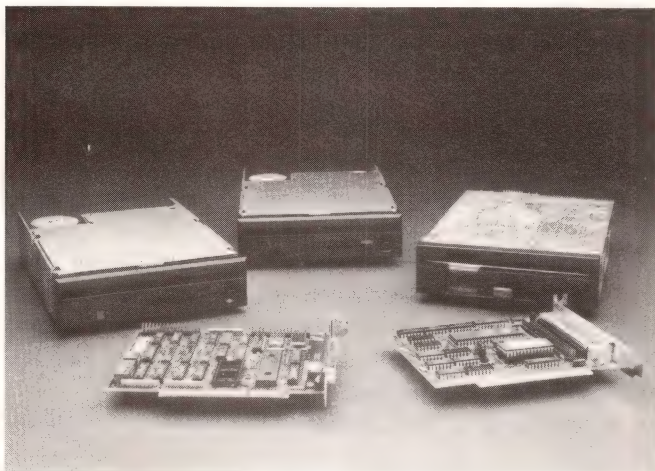
Although the Kodak 12 and Data Technology TakeTen use the same media, the drives use different recording formats. Therefore, disks formatted and written on a drive from one of the companies cannot be read on a drive from the other company. The companies jointly developed the recording technology, but along the way disagreed on drive-design specifics. The disagreement spoiled the potential for a multiple-sourced drive.

The Iomega and Data Technology drives and the Kodak 12 all employ single-sourced disk cartridges with flexible media but hard-plastic shells. In fact, the media might be a major factor in your consideration of high-capacity floppy products. Iomega buys media and assembles its own cartridges. Kodak subsidiary Verbatim (Charlotte, NC) supplies media for the Kodak 20 and TakeTen.

Advocates of the nonstandard media claim that the hard shell is necessary to protect the media in high-capacity drives. The hard-shelled cartridges also include a rigid hub to improve the stability of the medium as it spins. Some designers are reluctant to use drives that require single-sourced media, though. In addition, the media cost substantially more than standard-floppy media.

Cartridges for the Iomega Alpha 20 and Alpha 10 cost \$140 and \$95, respectively, and the Beta 20 media sell for \$49. Kodak charges \$50 for Kodak 12 media, and Data Technology TakeTen cartridges cost \$39.95. Data Technology includes three cartridges with its personal-computer add-in packages.

The Kodak 3.3 and 6.6 use media that look like standard 5¼-in floppy disks. However, even the flexible-jacket disks sell for \$20 and \$28, respectively. Konica offers the KT-510 drive, which stores 10M bytes



Half-height 6.6M-byte (left), 3.3M-byte (center), and 12M-byte (right) floppy drives (Eastman Kodak Co)

Embedded-SCSI controllers allow programmers to develop operating-system software that handles write faults caused by medium removal and write protection.

on a disk with a flexible jacket. In fact, the Konica product can read but not write 5¼-in. 360k- and 1.2M-byte disks written on IBM-compatible personal computers. The Konica drive sells for less than \$400 (10,000) and, like the other products, includes an embedded-SCSI controller. Media for the Konica drive sell for \$10 to OEMs and for \$25 to retail customers.

The prices for high-capacity media are high because medium manufacturing yields are low and the disks must be servo written. The process of writing servo information on the disk typically occurs during the manufacturing process and adds capital-equipment and labor costs to the medium cost.

The recording densities on 3M- to 20M-byte disks mandate that servo information be written on the disk, and all the products discussed here employ a servo-controlled system. The servo information provides constant feedback to the electronics that control head position. Standard floppies use stepper motors with no feedback to control the heads. Konica is striving to develop a low-priced servo writer for in-house use and for sale to medium suppliers.

To achieve the available capacities, most of the drives use floppy-disk recording techniques. In floppy drives, the head is in contact with the medium while reading or writing data. Each Iomega drive uses the Bernoulli principle during operation and, in fact, is trademarked the Bernoulli Box.

The Bernoulli principle describes the stabilization that occurs in flexible media spinning at high speeds. Because of the stabilization, engineers designed a drive that spins faster than traditional floppies do. In addition, the floppy medium flies over the head much as a

Winchester head flies over a rigid medium. Reading and writing, therefore, do not necessitate head/medium contact. The head is close enough to the medium to pick up contamination from the medium's lubricant zone. Iomega recommends monthly head cleaning (which takes less than five minutes) to guarantee reliable storage. Some users, however, report that heads should be cleaned weekly.

Advocates of the floppy-disk recording technique claim it is the more reliable and better proven technology. Iomega, though, believes that its design results in less medium wear. No manufacturer provides meaningful specs on medium and drive lifetime. If you consider using a high-capacity floppy disk in an OEM design, you had best do a life-cycle test on the product of your choice in the target environment.

Floppy drives rival Winchester specs

Although medium or interface issues might dissuade you from choosing a high-capacity floppy-disk drive, the drives have performance specs that rival low-cost Winchester. The Kodak 3.3 and 6.6 only offer 160- and 225-msec access times, respectively, and transfer data at 500k bps. But the Kodak 12 and Data Technology TakeTen have 65-msec average seek times and 2.2M-bps transfer rates. The Konica KT-510 transfers data at 1.6M bps and features a 75-msec average seek time.

The high-capacity floppy drives transfer data faster than standard floppy drives primarily because of increased recording densities. The drives use recording densities from 18k to 23k FCI (flux changes per inch). The servo-controlled head-positioning electronics account for the seek-time improvements over standard floppy-disk drives. Because the Iomega drives spin the media faster than other vendors' drives do, the Alpha drives transfer data at 1.13M bytes/sec, and the Beta 20, at 666k bytes/sec. The drives have average seek times of about 40 msec.

Although the performance specs do compare favorably to low-end Winchester specs, Dataquest's Devin claims the high price of drives and media will keep them from becoming a mainstream primary-storage option. You can mail order a 20M-byte Winchester for less than \$300. And Winchester, although not removable, are more reliable than floppies.

In certain instances, however, the high-capacity floppies prove cost effective as primary storage. For example, a 20M-byte Winchester costs \$300 every time you buy one. With removable floppies you only buy additional cartridges to add capacity to a system. In office

For more information . . .

For more information on the high-capacity floppy-disk drives discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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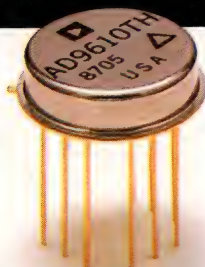
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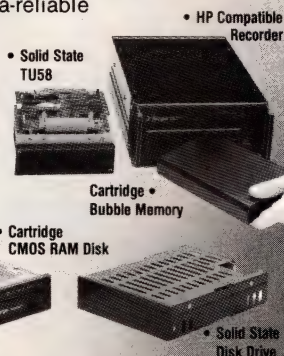
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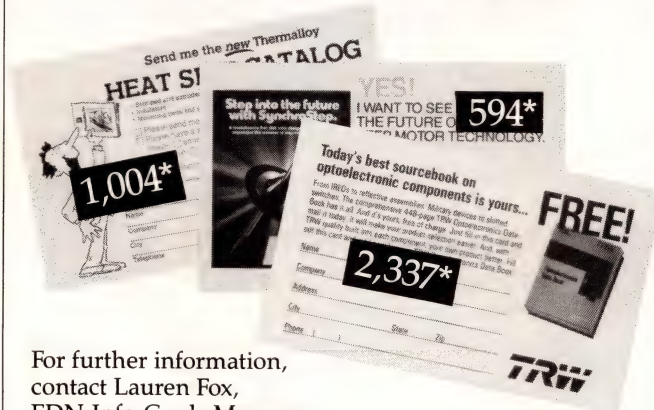
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environments, several people can share a computer, and each person can have one or more cartridges to use. Companies can also easily transport large amounts of data from one computer to another.

The floppy drives also find use in applications requiring data security. For military, company-confidential, or financial-security applications, you could use high-capacity floppy storage and lock the cartridges in a vault at night.

Despite such applications, Devin does not expect any currently available product to become an industry standard. Konica believed its product could have served as a de facto standard until IBM's recent announcement of a family of personal computers with 3½-in. peripherals. Devin does believe that the companies can be moderately successful continuing to sell drives as personal-computer add-ins.

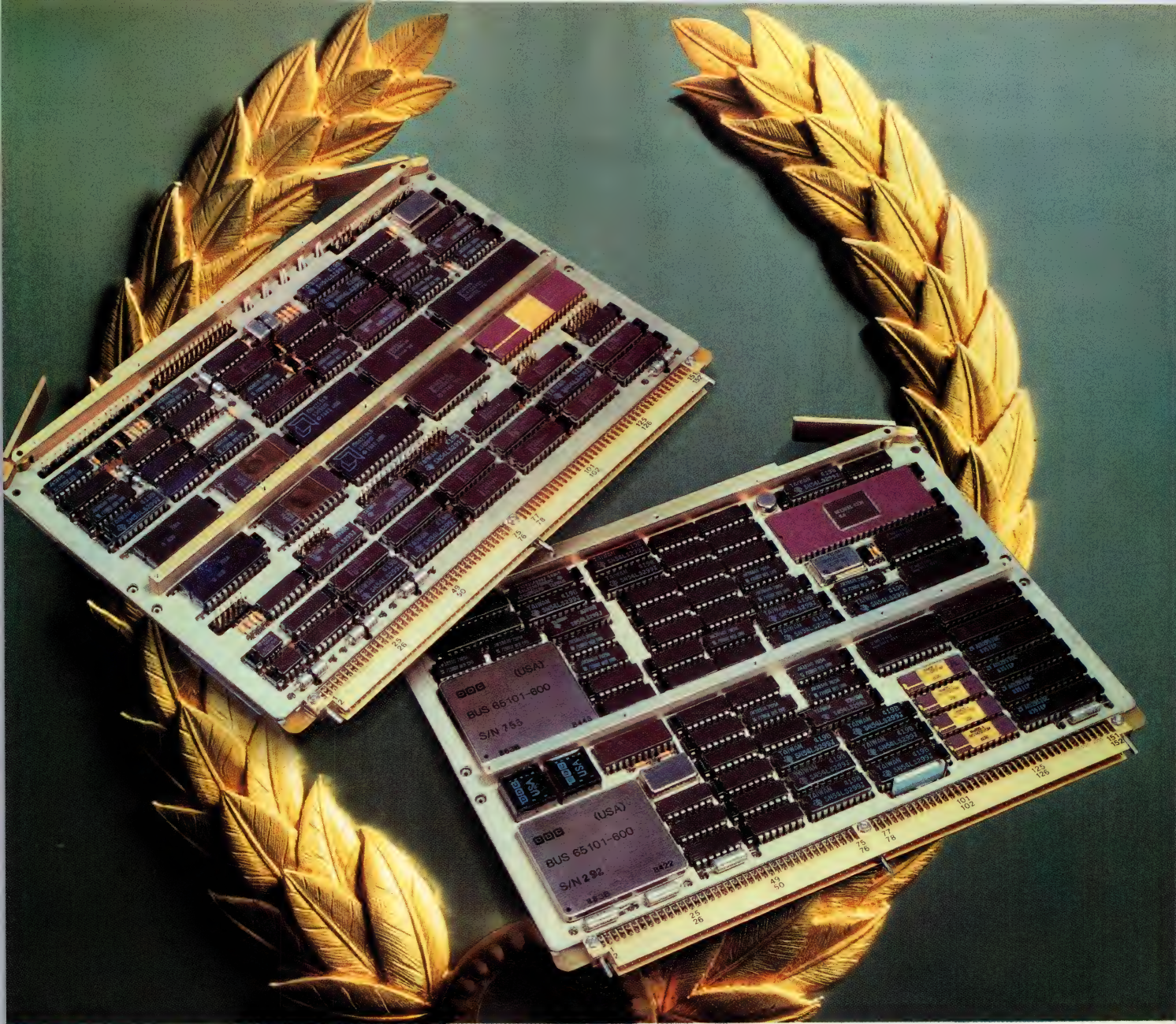
In addition, Devin believes that some manufacturer may establish an industry standard with a 3½-in. high-capacity floppy drive that uses standard media. He expects barium-ferrite media and head/medium combinations that allow 36k- to 50k-FCI recording densities to lead the way to future products. Devin predicts that a 3½-in. standard with 20M-byte capacity may take hold and that commercial acceptance of such a product could occur in 1989.

Several companies are rumored to be working on 3½-in. products. In addition, Toshiba (Santa Clara, CA) and NEC (Bosborough, MA) have made technology announcements concerning 3½-in. products. Toshiba plans 4M- and 16M-byte products that use perpendicular recording techniques. NEC has announced plans to develop a 6M-byte drive. Finally, a recent start-up, Brier Technology (San Jose, CA), has announced its intention to develop a high-capacity removable-disk drive with an intelligent interface.

Devin thinks the high-capacity 3½-in. floppies could play a key role in personal computers by 1990. He also predicts, however, that semiconductor-based data-storage modules may compete with or complement the floppy drives. Devin expects the modules to be small pc boards with 2M bytes of RAM each. A computer would accommodate four such boards, and end-user cost would be less than \$10/M byte. And Devin believes IBM has plans to use such modules in current or future personal computers.

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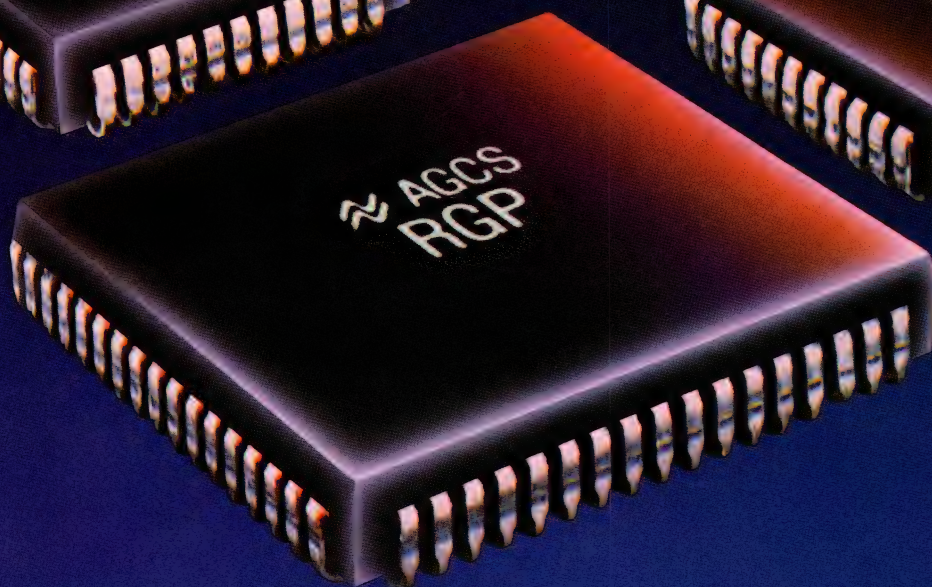
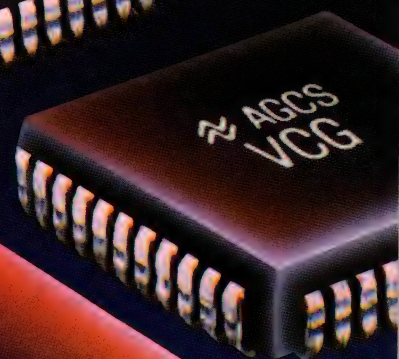
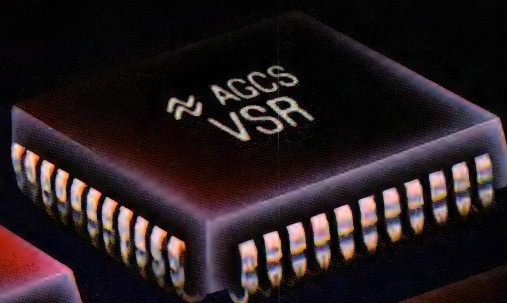
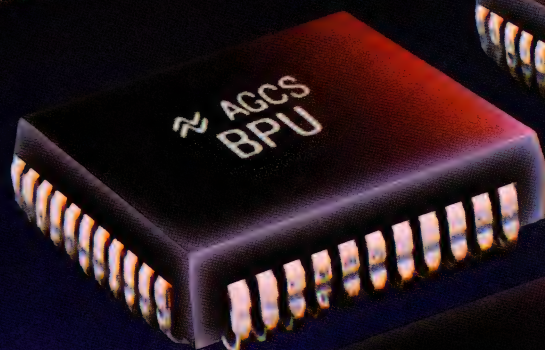
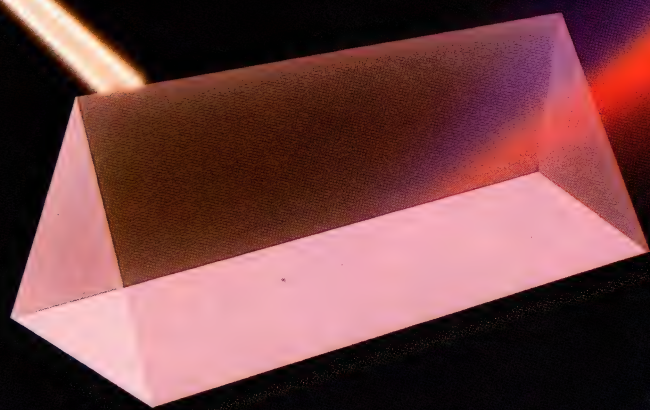
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Video Clock Generator (VCG). A timing and control generator providing all of the synchronization signals needed by a graphics system, with a pin-programmable pixel frequency of up to 225 MHz. Available now.

Video Shift Register (VSR). A parallel-to-serial shift register capable of serial output shift rates up to 225 MHz. Available now.

All devices available in PLCCs.

speed performance as a black-and-white application.

In fact, you can design an entire range of graphics systems without having to "reinvent the wheel" each time, by using the same hardware building blocks and the same central software in each of the systems.

THE MULTIPLE-CHIP SECRET

The secret to all this flexibility and performance is our unique multiple-chip, modular approach. Rather than trying to squeeze all the important graphics functions onto a single chip — which would require some significant design and performance

compromises — we've partitioned appropriate functions onto individual building-block ICs. This allows us to optimize the design of each chip, and allows you to optimize your own design for your particular application.

GRAPHICS WITHOUT LIMITS

What matters most about the Advanced Graphics Chip Set, of course, is what it does for *you*. And that answer is clear when you consider its high performance, its modular approach, its open architecture, and its programmability: It gives you graphics without limits. It gives you true design freedom. It gives you the opportunity, for the first time, to design a graphics system "custom fit" to your exact specifications.

So what are you waiting for? If you're tired of those limited single-chip solutions bogging down your designs, take a look at the Advanced Graphics Chip Set. And learn how you can design a graphics system to match your needs... as well as your imagination.

For more information and availabilities, just contact your local National Semiconductor Sales Engineer or write:

National Semiconductor
Advanced Graphics, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

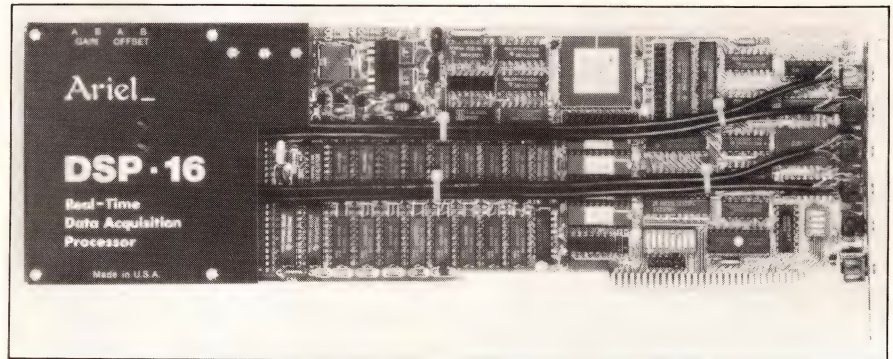
 **National
Semiconductor**

Computers and Peripherals

Real-time digital signal processor features 16-bit data acquisition

The DSP-16 combines 16-bit data acquisition with the Texas Instruments TMS32020 digital signal processor, a 512k-byte data buffer, and 16-bit precision analog outputs on one IBM PC card. A dual-channel 16-bit A/D converter with sample and hold, a dual-channel 16-bit D/A converter, and 20-kHz antialiasing filters are provided for input and output. The processor can buffer 256k samples of incoming or outgoing data (optionally expandable to 1M) with programmable sampling rates from 5 to 50 kHz. Its 16-bit resolution and 50-kHz sample rate make it suitable for full-bandwidth, high-fidelity audio applications. The two input and two output channels are available at four minijack connectors mounted on the panel bracket. Typical analog dynamic range is 85 db with 0.08% THD.

A driver, written in assembly language, with interfaces for Basic, Pascal, C, Fortran, and assembler



controls the DSP-16. The PC Sampler, a software package consisting of a program development system and five software application programs, is included with the processor. The application programs are data acquisition, digital audio effects, storage oscilloscope, audio loop editor, and waveform synthesizer.

Two options are available: The first substitutes a 40-MHz TMS320C25 DSP chip for the 20-MHz chip. The TMS320C25 runs

at full speed without wait states and doubles the instruction speed from 5 to 10 MIPS. The second option is a prototype board that plugs into the DSP-16 and allows you to interface external circuitry to the DSP. A memory space of 128k bytes and eight I/O port addresses are available on a 20-in² card. The basic DSP-16 is \$2495.

Ariel Corp, 110 Greene St, Suite 404, New York, NY 10012. Phone (212) 925-4155. TLX 4997279.

Circle No 665

Low-cost 3½-in. Winchester drive provides 20M bytes of storage capacity

The Spartan 20 3½-in. Winchester disk drive stores 20M bytes and is designed for cost-critical applications; it eliminates 50% of the parts traditionally found in 3½-in. drives. The drive excludes, for example, the optical sensor usually required to locate Track 0; instead it uses built-in intelligence and a special code written on the disk's surface. The drive also eliminates the traditional index sensor by using the drive motor's internal Hall-effect devices and another signal on the disk.

The Spartan 20 features a format-



ted capacity of 20.1M bytes, a standard ST412 interface (5M-bps transfer rate), and an average disk access time of 60 msec. It has two disks with four read/write heads and a maximum track density of 800 tpi. A 3-phase motor allows a starting

torque of 170 cm/g, which makes the speed ripple more uniform than single-phase motors. Power requirements are 5V at 0.52A and 12V at 0.74A typical, with dissipation rated at 11.5W average. MTBF is 28,000 hours and mean time to repair is 20 minutes. The Spartan 20's package measures 1.63×4.0×5.75 in.; it weighs 1.6 lb. Less than \$250 (OEM).

Lapine Technology Corp, 182 Topaz St, Milpitas, CA 95035. Phone (408) 262-7077. TLX 171693.

Circle No 667



Now, high-capacity disk drives with a name that makes a difference.

Performance isn't the only factor to weigh when choosing components for your PC system. You also need to be comfortable with your supplier's reputation and reliability.

That's why it makes sense to look to Kodak's new family of 3.3, 6.6, and 12 megabyte flexible disk drives and Verbatim media. You not only get our proven servo-embedded tracking technology, you get the assurance of doing business with a company known for manufacturing quality. Technological innovation. Product support. And financial security.

These disk drives are just the first in a new generation of data storage products backed by Kodak's commitment to providing exceptional reliability and value.

For more information, write or call today.
Kodak Mass Memory Division,
343 State Street, Rochester, NY 14650.
1-800-44KODAK, ext. 991.

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Computers and Peripherals

PC-compatible desktop scanner digitizes a range of printed images and texts

The ScanJet is a flatbed desktop scanner that enables personal-computer users to electronically scan printed images and text from a broad range of documents. For use in desktop-publishing applications, the monochrome scanner works much like a photocopier; instead of paper copies, however, it makes electronic copies for hard-disk storage. The flatbed design enables you to scan loose-leaf and bound volumes, photographs, magazines, and oddly shaped documents. The flatbed scanning surface is 8.5×11 in. An optional 20-pg automatic feeder allows you to scan larger pages and multiple-page documents.

Software lets you select a resolution from 38 to 300 dots/in. The ScanJet can scan a full-page image



at 300 dots/in. and store the data on a hard disk in 20 sec. You can reduce an image's size to as little as 13% or enlarge it to 1578% (depending on resolution). The scanner can distinguish among 16 levels of gray.

Three types of reproduction are available. Binary is used for line art and text not requiring gray scale. Dithering is used in photograph reproduction where the pattern of identically sized dots are varied to represent different levels of gray.

And gray scale is similar to the process used in publishing.

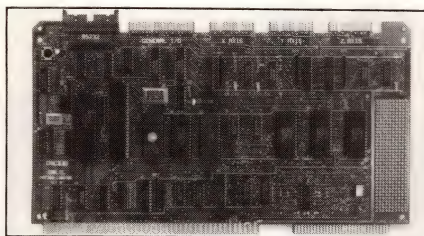
A bidirectional Centronics interface card lets you move data from the scanner to the computer for processing and storage. The card works with the HP Vectra PC, IBM PC/XT or PC/AT, and compatible systems. Two software packages, MS-DOS and MS Windows, let you store scanned data in several different file formats such as Pagemaker, Professional Publisher, and Spellbinder Desktop Publisher. The ScanJet costs \$1495; the interface card, coupled with software, is \$495.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 681

Intelligent motion controller runs one to three servo motors

The DMC-230 Series programmable servo controller is contained on a Multibus card. It controls the motion of as many as three dc or brushless-dc motors that have incremental encoder feedback. Modes of motion include positioning, jogging, or homing. You can specify the motion profiles for each motor separately or as a sequence of coordinated vectors. And you can specify as many as 16 straight-line or arc segments for one continuous-motion sequence. You instruct the DMC-230 using the Multibus or RS-232C port that you can daisy chain. The controller's nonvolatile memory stores programs, thereby eliminating the need for a host computer or reprogramming on power-up. To



make motion commands, you can use conditional statements, which make decisions based on the logical state of I/O lines.

The controller uses a digital filter for compensating the closed-loop system. This filter provides system gain, damping, and integration for optimizing system response. The filter coefficients can be adjusted on-the-fly. Several error-handling features are included, such as

automatic shut-off for excessive position error, emergency-stop inputs, and programmable torque limits. The DMC-230 also provides acceleration feedforward and frictional bias for reducing error during acceleration and error due to friction.

The additional elements required for a typical servo system that uses the DMC-230 motion controller include the host computer; a motor; incremental encoder and power amplifier for each axis of motion; external switches, such as end-of-travel and homing inputs; and power supplies. DMC-230, \$1995.

Galil Motion Control Inc, 1054 Elwell Ct, Palo Alto, CA 94303. Phone (415) 964-6494. TLX 171409.

Circle No 666

OKIDATA PRINTERS FROM HAMILTON/AVNET: THE OFFICE HELP THAT NEVER TAKES A BREAK

WORLD'S LARGEST INVENTORY WITH 57 LOCATIONS

Workaholics. That's what Okidata printers are. Since they never know when to quit, you can always depend on them. Okidata's reliable reputation is well known industry-wide because of the stringent quality control tests their printers must pass.

Okidata has a broad line of printing products for you to choose from. All have distinct qualities to fulfill your individual needs. All are available at the largest, most service-oriented distributor in the world — Hamilton/Avnet.

This includes the space saving 190 Plus series, which is the most popular printer series in its class. The 192/193 Plus combine the industry's most advanced print-head, carriage drive system and electronics available. This gives you exceptional quality and longer life for your printer.

The 290 series has a broad capability that enables you to operate your printer with almost any micro- or minicomputer, and handles virtually any size of paper, even 4-part forms! This versatile series includes the 292, the wide carriage 293, and the extremely fast 294, which prints NLQ at a speedy 100cps. In fact, the 294 is so fast, it can print 400cps in high speed draft mode!

To order contact your local Hamilton/Avnet sales representative or call 1-800-4-HAMILTON (1-800-387-6879 in Canada; 1-800-387-6849 in Ontario and Quebec).

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CIRCLE NO 125



We never thought of ourselves as music makers. But we are now. Because we built the 286 CPU board and other components that allow Personics' amazing CD ROM jukebox to duplicate recordings for retail customers. And soon we'll be playing near you.

In fact, NCR's OEM PC-based technology is finding its way into a lot of places you might not think. Like medical imaging and diagnostic equipment. Environmental control systems. Robotics and manufacturing control systems of every description. And everywhere we go, NCR PC technology is proving itself an attractive alternative to other architectures.

That's because our PC technology is so versatile.

We put the RAM in the ram-a-lam-a ding-dong.

With an innovative approach to assembling the chips, boards and subsystems you need for your specific application. Without chewing up the calendar and your R&D budget in the process.

In short, we're easy to work with. From design to production to delivery. Because we have the engineering know-how and the manufacturing can-do to deliver the goods. Without hitches, without surprises, without fail.

So if you're looking into developing new products, or finding ways to improve your current ones, look into NCR. For more details about how NCR PC technology can fit into your plans, call us at (513) 445-0670.

And who knows, we could end up making beautiful music together.

CIRCLE NO 128

**A SMART FOUNDATION
TO BUILD ON.**



NCR Corporation
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Dayton, Ohio
45479

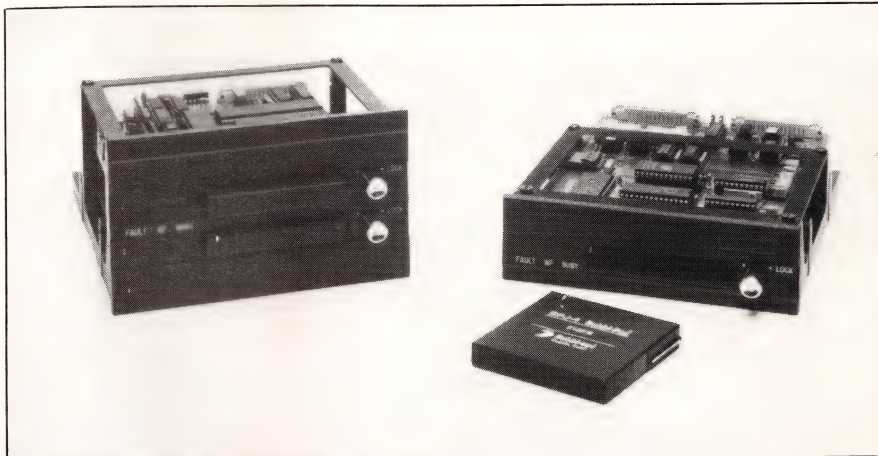


Computers and Peripherals

Bubble-memory cassette drives withstand harsh environments

The BDJ-1 solid-state bubble-memory cassette system contains two cartridge drives for 512k-byte bubble cassettes. The BDJ-2 has a single cartridge drive. Both systems are fully compatible with the DEC Q Bus, the VME Bus, STD Bus, Multibus, Versabus, or the IBM PC when any of those systems uses one of the company's controllers. Or you can control either memory system via an internal controller that has an RS-232C, RS-422, or SCSI interface. The BPJ-4 Bubbl-Pac cassette provides 512k bytes of storage in a metal package.

Because they're nonvolatile and solid state, they tolerate shock and vibration well. The modules can replace a floppy-disk drive system because they are the same physical size; the modules also mount in the



same footprint and mounting holes as a standard 5¼-in. floppy-disk drive. Access time is 20 msec average with a data-transfer rate of 60k bps when driven by an external controller (30k bps when driven by the internal RS-232C or RS-422 control-

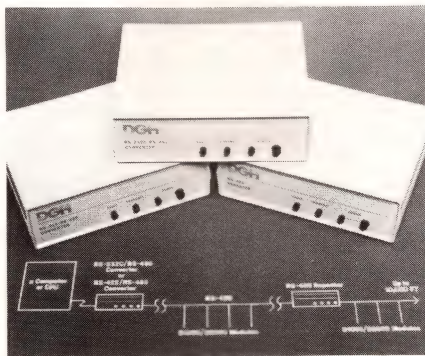
ler). Power requirements are 5 and 12V at less than 12W. BDJ-2, \$787; BDJ-1, \$1291.

Bubbl-tec, 6805 Sierra Ct, Dublin, CA 94568. Phone (415) 829-8700. TWX 910-389-6890.

Circle No 683

RS-232C to RS-485 converters control bus direction automatically

The A1000 converter boxes convert RS-232C and RS-422 communication standards to the correct electrical signals required by RS-485. The RS-485 standard is the preferred method of field communications when many modules are interfaced to a host computer over long distances. By using RS-485, the A1000 Series allows bus lengths up to 4000 meters and baud rates to 38.4 kHz. The A1000 unit automatically supervises the transmit/receive bus direction without handshaking signals from the host. Therefore, you can use host software written for RS-232C or RS-422 without modification. RS-485 bus control is transpar-



ent to the user. The series has three models: the A1100 is an RS-232C to RS-485 converter; the A1200 is an RS-422 to RS-485 converter; and the A1300 is an RS-485 repeater.

You can use the A1300 unit to

extend an RS-485 bus when you want to connect more than 32 modules to a host port. The repeater amplifies the RS-485 signal to drive as many as 32 additional modules. By using multiple A1300 units, you can interface as many as 124 modules to the host. Each A1000 contains a 24V, 1A power supply. Power requirements are 110/220V ac, 50 to 60 Hz. The units also optically isolate the host to 1500V ac against destructive faults or static charges. Each unit costs \$250.

DGH Corp, Box 5638, Manchester, NH 03108. Phone (603) 622-0422. TWX 510-601-6112.

Circle No 686

REAL-TIME DIGITAL FILTERING NEVER LOOKED BETTER.

When it comes to high-speed digital filtering or correlation, Zoran's Digital Filter Processor (DFP) family makes it look better than ever.

Using system processors that deliver the high performance of building blocks. But with the high integration of a single device.

You can execute complete 3 x 3 real-time imaging convolutions or correlations with a single DFP.

In high-speed satellite communications, digital radios, or radar, you can cascade multiple DFPs to achieve a higher sample rate and longer filter length, eliminating analog filters.

High-resolution video is easy with the 9-bit ZR33891, which delivers the longer word length and extended precision you need for studio broadcast applications.

You'll like the look of our tools and support. The shorter your development cycle, the better it looks. Which is why our VAX™ and PC-based tools provide you with everything you need for fast and easy implementation.

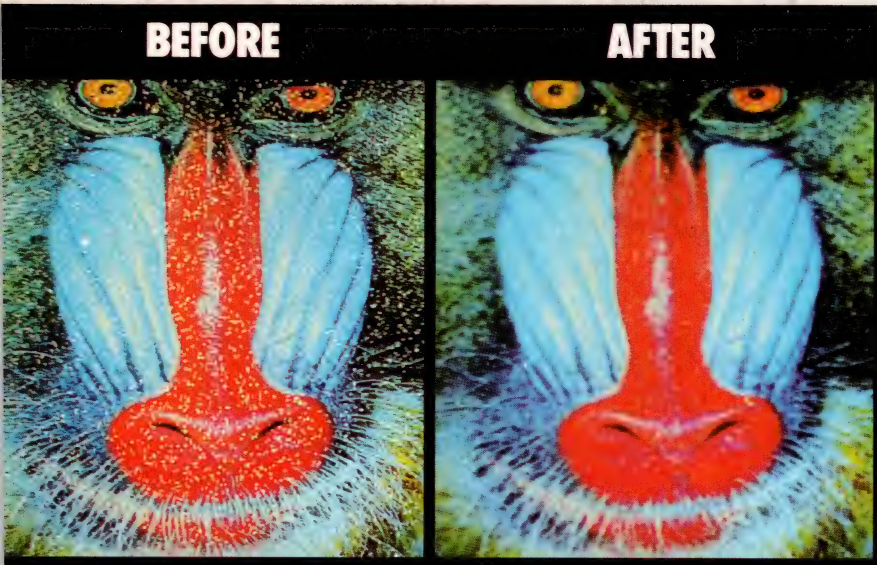
Including software for filter design and coefficient selection. And plug-in boards for real-time filter evaluation.

All of which explains why Zoran's DFP and Vector Signal Processor (VSP)™ product families provide the fastest, easiest solutions for computation-intensive applications.

Best of all, we're shipping products now. Instead of simply announcing them. Which means you don't have to wait to get the jump on your competition.

Take a look at our free databook. Call 1-800-556-1234, ext. 99 (outside CA), or 1-800-441-2345, ext. 99 (in CA).

Or write Zoran Corporation, Dept. MC-2, 3450 Central Expressway, Santa Clara, CA 95051, 408/720-0444, ext. 3523. We'll make you look good in a hurry.



512 x 512 high-resolution image with randomly distributed noise.

Zoran's DFP performs *real-time* low-pass filtering to remove noise using a 7x7 convolution.

Each DFP is configured as a unique parallel-processing system capable of performing 320 million operations per second. At a blazing 20MHz throughput.

What's more, you can parallel multiple devices to reach throughput rates in excess of 120MHz.

And you'll do it in far less space, thanks to our highly integrated, proprietary architecture.

Which lets you design your system in a lot less time. At a lower cost. And with greater ease and flexibility than you ever thought possible.

The DFP is so flexible you can use a single device to easily implement a 32-tap decimate-by-four FIR filter.

The DFP makes all your applications look good. Take inspection, for example.

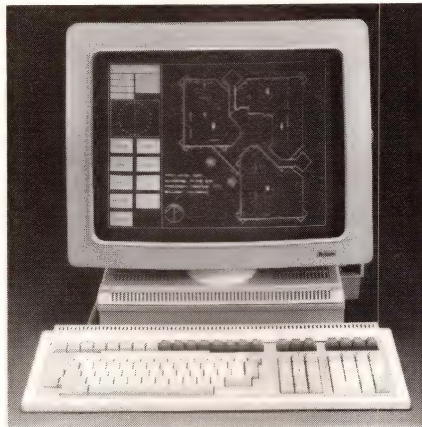


Computers and Peripherals

19-in. color-graphics terminal features an onboard 16-MHz 68020 μ P

The MX1000 19-in. color-graphics terminal provides screen resolutions of 1024 \times 768 or 1024 \times 784 pixels and can simultaneously display 16 (optionally 256) colors from a palette of 256k colors. To ease software integration, the terminal can emulate a variety of industry-standard terminals.

Based on a 16-MHz 68020 μ P, the monitor is equipped with 1M byte of 32-bit segment memory for the storage of picture definitions, and a 16k-byte cache memory to increase processing speed. You can expand the segment memory to 4M bytes and add a 68881 math coprocessor on the mother board. Five expansion slots for plug-in boards are available on the mother board to provide additional functions. The monitor pro-



duces a noninterlaced scan with a refresh rate of 60 Hz and achieves a drawing speed of approximately 1.5M pixels/sec.

Tektronix-4111, -4109, and -4109A graphics-mode emulations are provided with the terminal;

DEC-VT240 and -VT241, Retro-graphics VT640, and Westward 3220 emulations are available as options. Standard alpha-mode terminal emulations include DEC-VT52, -VT100, -VT132, and -VT220, and the screen can display 48 lines with 80 or 132 cpl. Support for a variety of printers is standard; support for a joystick, mouse, trackerball, or digitizer tablet is optional. From approximately \$9000.

Pericom International, Rockingham Dr, Linford Wood, Milton Keynes MK14 6LH, UK. Phone (0908) 670000. TLX 826442.

Circle No 673

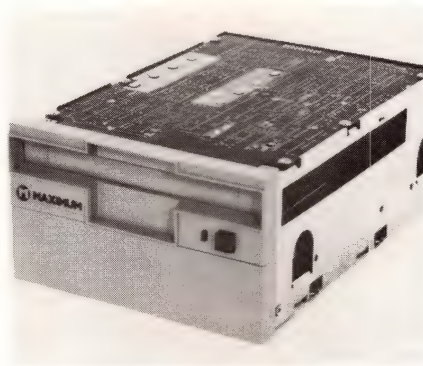
Pericom Inc, 2291 205th St, Suite 103, Torrance, CA 90501. Phone (213) 618-9190.

Circle No 674

244M-byte optical disk drive works with IBM PCs and compatible systems

The APX-3000 5¼-in. optical disk drives offer 244M bytes of removable storage capacity. The removable write-once optical system provides mass storage for IBM PCs, PC/XTs, PC/ATs, and compatibles by running MS-DOS in a transparent mode. A controller, which requires a single expansion slot, attaches to the IBM PC and supports the drive through an ESDI interface. The controller board has an Interleaved Reed-Solomon Error Detection and Correction code (EDAC).

The drive features a data-transfer rate of 2.5M bps, rotational speed of 1800 rpm, average access time of 135 msec typ, track-to-track seek of



1 msec, latency of 16.7 msec typ, and 2 sec of spin-up and 3 sec of spin down. MTBF is 15,000 hours, and MTTR is 30 minutes. The chassis dimensions are 8 \times 3.25 \times 5.75 in. The drive weighs 4.5 lbs. Power requirements are 12V dc at 1.37A (nominal)

and 5V dc at 0.8A (nominal); total power consumption is 20W.

The removable write-once optical media is on an encapsulated data surface providing 244M bytes of user capacity. It's packaged in a plastic cartridge with access shutter. The cartridge includes a write-protect tab and measures 5.9 \times 5.4 \times 0.4 in. Projected lifetime for a write-once media is five years (min); for a readable media, the figure is 10 years (min). APX-3000, \$2695; media is priced at \$75.

Maximum Storage Inc, 5025 Centennial Blvd, Colorado Springs, CO 80919. Phone (303) 531-6888.

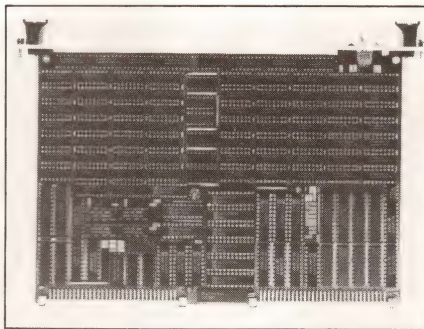
Circle No 669

Computers and Peripherals

VME Bus RAM boards support 30M-byte/sec data transfers

To speed memory access, the SYS68K/DRAM-6 and DRAM-7 VME Bus memory boards prefetch the next 32-bit word from memory while the current word is being transferred over the VME Bus; they interleave these accesses between two dynamic-RAM arrays. As a result, they can achieve a data-transfer rate for sequential-address read accesses of 30M bytes/sec, with a typical access time of 50 nsec. The DRAM-6 and DRAM-7 boards provide 2M and 8M bytes of memory, respectively, with full parity generation and checking.

All write cycles to the memory have a typical write access time of 50 nsec, and nonsequential-address read accesses have a typical read access time of 160 nsec. Refresh cycles for the dynamic RAM occur



every 15 μ sec, but you can force a refresh cycle immediately before accessing the memory to ensure that subsequent read operations have a read access time no worse than 180 nsec. When parity errors occur, the boards generate a VME Bus bus-error signal.

Both boards are capable of all the data-transfer types listed in the VME Bus (IEEE-1014) specifica-

tion, including unaligned transfers and read-modify-write cycles. Data-bus transfers can be 8-, 16-, 24-, or 32 bits wide, and the boards can decode either 24- or 32-bit VME Bus addresses. You can select by jumper the boards' base address in 1M-byte steps, within any 24M-byte memory page. In addition, a switch is provided to isolate the memory from the VME Bus without loss of stored data. SYS68K/DRAM-6, DM 2995; SYS68K/DRAM-7, DM 8995.

Force Computers GmbH, Daimlerstrasse 9, 8012 Ottobrunn, West Germany. Phone (089) 600910. TLX 524190.

Circle No 671

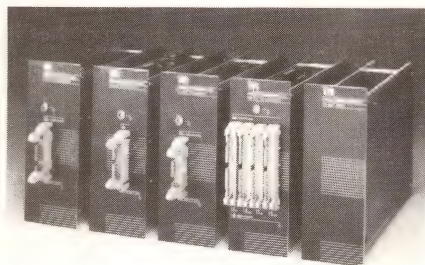
Force Computers Inc, 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410. TLX 172465.

Circle No 672

Instrumentation modules for STD Bus provide accurate low-level measurements

The MTI-1000 is a series of smart instrumentation modules for the STD Bus. They are designed for data acquisition, test and measurement, and laboratory and analytical instrumentation. Each module provides bus isolation of 1000V and is separated from adjacent modules or STD Bus cards by thick plated steel shields. This shielding, together with massive ground planes in all analog circuitry areas, ensures accurate low-level measurements without interference.

Five modules are available. The MTI-1007 is a high-speed user-configurable 12-bit analog-to-digital converter. You can multiplex via



relay scanning or a fast FET mux. The MTI-1033 is an 8-channel D/A converter, suitable for IC, component, and circuitry testing. An individual 13-bit D/A converter (12 bits plus a sign) drives each channel.

The MTI-1091 is a general-purpose scanner for test and measurement applications. You can use it as

an 8-to-1 mux, a dual 4-to-1 mux, or other user-programmable configurations. The MTI-1092 is a high-speed 128-channel multiplexer. Channel selection with CMOS analog switches takes 10 μ sec. You can customize the MTI-10XX module for 8088- or Z80-based systems. It provides the hardware and software basis for STD Bus I/O. Each MTI-1000 module is a μ C-based measurement system. MTI-1007, \$820; MTI-1033, \$665; MTI-1091, \$540; MTI-1092, \$580; MTI-10XX, \$285.

Miller Technology Inc, 647 N Santa Cruz Ave, Los Gatos, CA 95030. Phone (408) 395-2032.

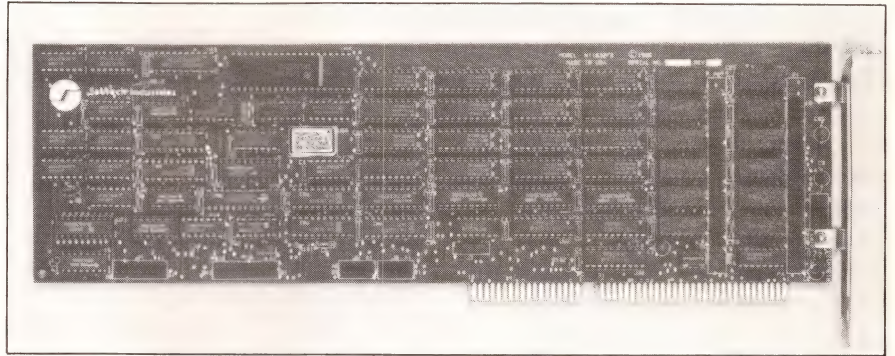
Circle No 682

Computers and Peripherals

A low-cost naval interface board replaces high-cost computers, runs on the IBM PC/AT

The Naval Tactical Data Systems NT1632FS interface board can replace expensive military computers (such as the AN-UYK series of computers used on Navy fleet ships) and peripherals (such as a Digital Display Indicator). The interface fits into one full-length slot in either the IBM PC/AT or compatibles. The board also provides full-duplex 32-bit I/O support for communications with Navy tactical computers and peripherals.

Operation modes, whether peripheral, host computer, or inter-computer, are selectable under software control. For ease of use, the interface features a data-transfer rate to 4M bytes/sec; DMA for either polled or interrupt mode with separate registers for input and output channels; and a transparent RS-422 port. The board runs at 6, 8,



or 10 MHz on the PC/AT with or without wait states. Switch-selectable address decoding handles 32 different I/O addresses ranging from 200 to 3FF (hex). The interface conforms to MIL-STD-1397 A and B (fast/slow). An optional attachment board conforms to MIL-STD-1397 C (ANEW).

Assembly-language source code for the I/O drivers is included so you

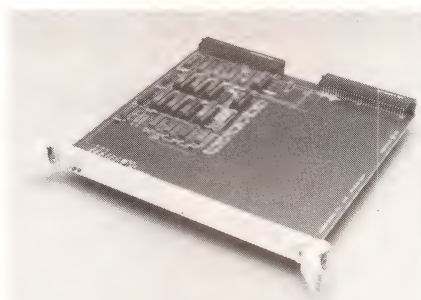
can write software and diagnostics. A sample Pascal program demonstrates the use of these drivers. Loopback test cables are provided as well. The NT1632FS costs \$2300; the optional NTDS ANEW attachment board costs \$950.

Sabtech Industries, Box 1132, Yorba Linda, CA 92686. Phone (714) 630-9335.

Circle No 680

Low-cost central service module available for the Multibus II

The CSM-B (Central Services Module-Basic) is a cost-effective implementation of the central control functions defined in the Multibus II, IEEE P1296 specification (every Multibus II system using multiple processors requires the inclusion of these functions). The CSM-B manages the central system's clock generation, power down, reset, time-out, and assignment of IDs as defined by the Multibus II specification. It generates the Parallel System Bus clocks. The module supplies the bus clock (BCLK) 10-MHz signal and the constant clock (CCLK) 20-MHz signal to all boards interfaced to the system bus.



The CSM-B also provides a system-level reset/initialization signal to all boards interfaced to the system bus. It provides this signal when you press a front-panel reset switch or upon the assertion of an external reset signal or the restoration of system power. The module

signals time-out whenever it detects the failure of a board to complete a handshake.

At reset, the CSM-B supplies each board on the system bus with a slot ID and an arbitration ID. The slot ID allows the user to address any board by its physical position in the backplane. The board resides in slot 0 in a standard double-height Eurocard with DIN pin and socket connectors. \$315 (OEM qty).

Microbar Systems Inc, 785 Lucerne Dr, Sunnyvale, CA 94086. Phone (408) 720-9300. TWX 910-373-2047.

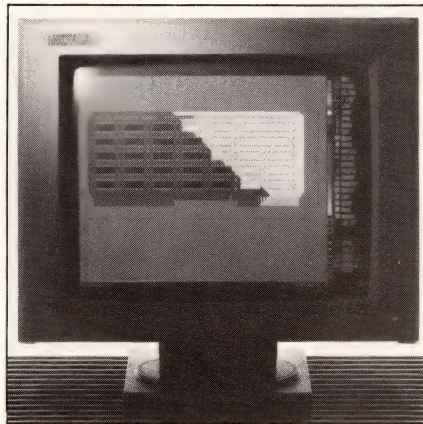
Circle No 678

Computers and Peripherals

Display systems turn personal computers into high-resolution graphics workstations

Based on Texas Instruments' 34010 graphics processor chip, the Xcelerator range of display systems for IBM PC/AT and compatible computers provides a display resolution of 1024×768 pixels. The range includes monochrome versions capable of displaying eight shades of gray and color versions capable of displaying 16, or 256 colors, from a palette of 16 million colors. The display's aspect ratio and resolution provide uniformly spaced square pixels, and freedom from 1-way stretch distortion.

Each system comprises a plug-in card for the IBM PC/AT and a CRT monitor. The card's 34010 graphics processor has an instruction set that includes general-purpose instructions, allowing you to run application programs with minimal intervention from the host processor. It's capable of continuous short-vector drawing at speeds of 80,000 vectors/



sec, long-vector drawing at 1.25M pixels/sec, and 8×16-pixel character generation at 25,000 cps. You can add an optional National Semiconductor 32081 floating-point processor to the card to enhance its computational capabilities.

The card can access as much as 7M bytes of display-list memory, which is enough for you to implement true zooming (as opposed to

pixel replication), and to manipulate zoomed or panned views of drawings in display windows. Program-development tools and driver software for a number of CAD and graphics packages are available.

Versions of the display systems are available for interlaced or non-interlaced displays. The monochrome system costs £2495, with color versions priced at between £4195 and £5395. The plug-in cards for the color systems are available separately for between £1900 and £2795.

Cambridge Computer Graphics Ltd, Unit 33, Clifton Rd, Cambridge CB1 4ZN, UK. Phone (0223) 214444. TLX 817274.

Circle No 675

Cambridge Computer Graphics, 6201 Ascot Dr, Oakland, CA 94611. Phone (415) 530-4148. TLX 230797032.

Circle No 676

9-in., half-rack fixed drive stores more than 1.03G bytes of data

The 9715-1000 FSD (Fixed Storage Drive) 9-in., half-rack rigid disk drive provides 1.03G bytes (unformatted) of storage in a sealed module. You can mount two FSDs side-by-side in a standard 19-in. RETMA rack. The drive has an average seek time of 14 msec and a track-to-track seek time of 4 msec. Because it can have 41,088 bytes per track and features 26 read/write heads, the 9715-1000 can transfer more than 1M byte of data without any mechanical movement of the positioner. The data-transfer rate is 2.46M bytes/sec (19.72 MHz) over the



SMD, SMD-E, or IPI interface. Data is recorded on seven platters (13 data surfaces), at densities of 1283 tpi and 20,254 bpi.

The drive uses LSI technology for the read/write, the transmitter/receiver, and μ P-controlled servo elec-

tronics. Heads are fabricated with thin-film technology. A universal 120 to 240V power supply (attached or remote) eases the integration of the drive. Total power consumption is less than 225W.

Specified MTBF is 36,000 hours; MTTR is 30 minutes. A 3-year warranty for the head/disk assembly is standard. \$6990 (250). Production deliveries are scheduled to begin in the third quarter.

Control Data Corp, OEM Product Sales, Box 0, Minneapolis, MN 55440. Phone (612) 853-3275.

Circle No 679

What's NEW

**Model 8600
80186 on STD Bus**
 • 80186 microprocessor runs at 10 MHz
 • STD Bus interface with RAM on board
 • 64K battery backed static RAM on board
 • 128K EPROM on board
 • Two serial and four parallel ports
 • Soft-Emulator links to PC for development

One of the 80186 microprocessors running at 10 MHz permits Cubit to offer the most powerful CPU board on the market today. The 80186 is a 16-bit microprocessor with 128K of on-board static RAM. The 80186 is a 16-bit microprocessor with 128K of on-board static RAM. The 80186 is a 16-bit microprocessor with 128K of on-board static RAM.

80186 Microprocessor
 The 80186 microprocessor is an advanced member of the 8086 family. It contains many key functions on a single chip, including a program counter, instruction decoder, and address and data buffers. The 80186 is a 16-bit microprocessor with 128K of on-board static RAM.

STD Bus
 The Model 8600 is the first STD Bus board to use the 80186 microprocessor. It is a compact board that fits into a standard STD Bus slot. The STD Bus is a 16-bit microprocessor with 128K of on-board static RAM.

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CUBIT BEARS COMPETITION!!

THE STD BUS

The STD Bus is a compact board that fits into a standard STD Bus slot. It is a 16-bit microprocessor with 128K of on-board static RAM. The STD Bus is a 16-bit microprocessor with 128K of on-board static RAM.

44180 ON STD BUS

The 44180 is a 16-bit microprocessor with 128K of on-board static RAM. It is a 16-bit microprocessor with 128K of on-board static RAM. The 44180 is a 16-bit microprocessor with 128K of on-board static RAM.

6502 ON STD BUS

The 6502 is a 8-bit microprocessor with 128K of on-board static RAM. It is a 8-bit microprocessor with 128K of on-board static RAM. The 6502 is a 8-bit microprocessor with 128K of on-board static RAM.

EXPANSION BOARDS

Expansion boards are available for the STD Bus. They include a 16-bit microprocessor with 128K of on-board static RAM. The expansion boards are available for the STD Bus.

OPTIMIZED PARALLEL I/O

Optimized parallel I/O is available for the STD Bus. It is a 16-bit microprocessor with 128K of on-board static RAM. The optimized parallel I/O is available for the STD Bus.

PARALLEL I/O

Parallel I/O is available for the STD Bus. It is a 16-bit microprocessor with 128K of on-board static RAM. The parallel I/O is available for the STD Bus.

CONVERTERS

Converters are available for the STD Bus. They include a 16-bit microprocessor with 128K of on-board static RAM. The converters are available for the STD Bus.

80186 MICROPROCESSOR

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Computers and Peripherals

Hard-disk subsystem links IBM PCs, Macintosh, and Apple personal computers

The Data Exchange SCSI mass-storage subsystem links the IBM PC, PC/XT and PC/AT with the Apple IIe/gs and Macintosh personal computers, enabling them to share files and exchange data. The subsystem consists of a SCSI hard-disk drive, which features 320M bytes of mass storage, and proprietary software that converts data developed on any of the three personal-computer systems in a way that lets any of the machines read that data. The system supports one Macintosh and as many as five IBM PC, PC/XT or PC/AT and/or Apple IIe/gs computers via SCSI interface cards. It can handle a maximum of eight computers and peripherals.

The Data Exchange features a data transfer rate of 1.5M bytes/sec. It uses a 25-conductor SCSI cable



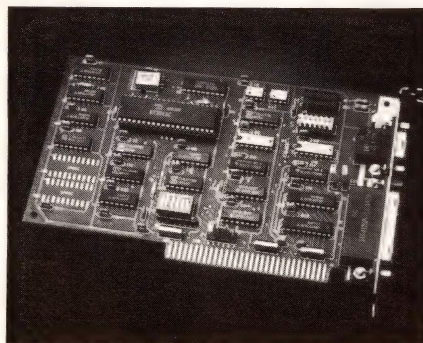
with a maximum length of 20 feet. \$8745, including a 1-year warranty. **CMS Enhancements Inc, 1372**

Valencia Ave, Tustin, CA 92680. Phone (714) 259-9555.

Circle No 670

IBM PC board links eight PCs for SNA communications

Clusternet II allows one IBM PC to be a server and emulate an IBM 3274 Cluster Controller; that PC can also support as many as eight PC workstations that communicate to an IBM mainframe in an SNA (Systems Network Architecture) environment. It operates on an IBM PC, PC/XT, PC/AT, or compatible computer and allows a cluster of eight PCs to emulate IBM 3278 display terminals over a proprietary local-area network. The Clusternet II connects to the host through an external synchronous modem as fast as 9600 bps. The proprietary network consists of a high-speed RS-422 serial link with a protocol



that transmits data at 19.2k bps between the designated server and the other workstations. The communications server PC requires 128k bytes of memory; for the workstation configuration, 64k bytes is required. ClusterNet II also emulates

IBM 3777 Remote Job Entry (RJE) functions to send batch jobs to the host.

The basic Clusternet II system links two PCs to a remotely situated IBM mainframe; it contains two circuit boards, floppy disks of SNA communications software, and cables. This package costs \$1795. To expand the LAN from three to eight workstations, a \$349 upgrade kit is required for each additional workstation.

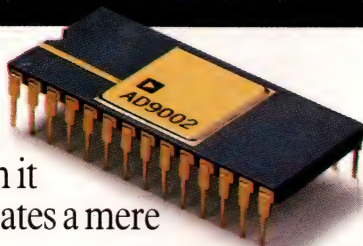
Intelligent Technologies International Corp, 737 Centre Dr, Foster City, CA 94404. Phone (800) 523-8396.

Circle No 685

OUR LIGHTNING- QUICK FLASH CONVERTER IS SO HOT BECAUSE IT'S SO COOL.

When an 8-bit flash converter operates at a blazing sampling rate of 150 MHz, that's hot. When it does it in a 28-pin DIP that dissipates a mere 750mW, that's cool.

Add to that the AD9002's bandwidth of 115MHz and an ultra-low input capacitance of 17pF that simplify your amplifier and system design.



All you need is a single - 5.2V power supply, which eliminates latch-up problems. Both military and industrial versions are available.

For more information on our new AD9002 flash converter, contact your nearest Analog Devices sales office.

And be cool.



The Designer's Advantage.

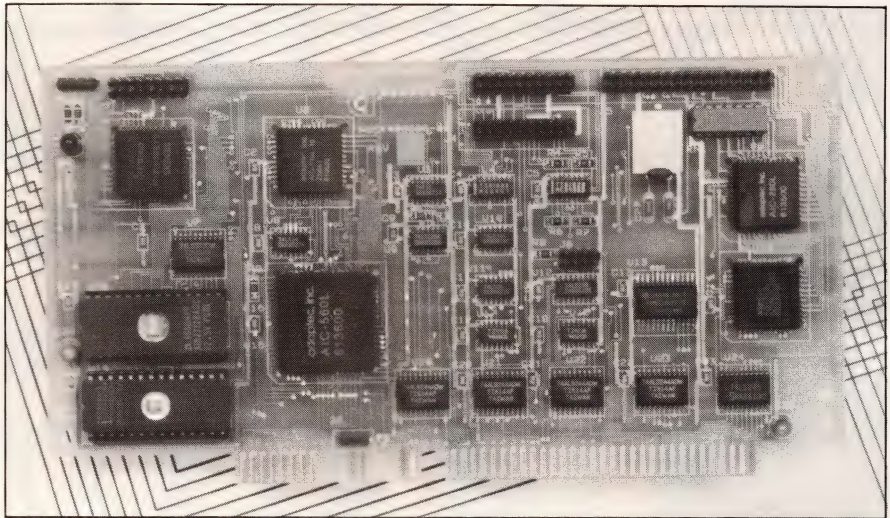
Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (303) 590-9952; Illinois: (312) 980-0300; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094, (713) 664-6704; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 28995; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050

Computers and Peripherals

2,7 ARLL controller boards increase data capacity and transfer rate by 100%

The ACB-238X controllers for the IBM PC/AT utilize 2,7 ARLL (advanced run-length-limited) encoding to increase both the data capacity and transfer rate of a drive by 100%. A 20M-byte ST506 drive, for example, when coupled with the ACB-238X, produces a capacity of 40M bytes. The 2,7 RLL (run-length-limited) encoding is more efficient than standard MFM (modified frequency modulation). ARLL is 2,7 RLL encoding running at 10M bps (standard MFM runs at 5M bps). The result is a 100% increase in speed and capacity over MFM. The controllers plug directly into the IBM PC/AT bus.

Noninterleaved operation is achieved when the controller reads an entire track of data in only one disk revolution. The controllers' 10M-bps noninterleaved operation allows a six times improvement over



the IBM PC/AT controller. The controllers meet the height requirements for smaller PC/XT enclosures and come in two versions: the ACB-1380 for one or two Winchester drives and the ACB-2382 for as many as two Winchester and two

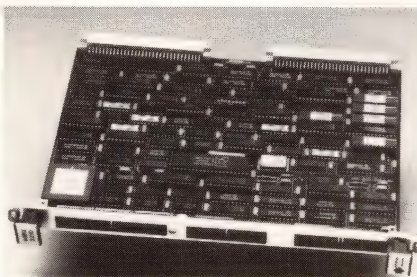
floppy drives concurrently. ACB-2380, \$150; ACB-2382, \$180 (1000).

Adaptec Inc, 580 Cottonwood Dr, Milpitas, CA 95035. Phone (408) 432-8600.

Circle No 677

VME Bus card combines three peripheral controller functions

The V/MIX 3210 Multifunction Peripheral Controller for the VME Bus combines three peripheral control functions on one card. You can access the three ports, which include a Centronics printer port, an electrostatic port (Versatec or Benson), and a SCSI port, as if they were DMA devices. The board saves card slots and reduces significantly the number of interrupts the I/O devices deliver to the host. The 3210 has a DMA channel for each I/O port so the host need service only one interrupt per block transfer instead of the usual interrupt per byte.



The SCSI port contains a 16k-byte pipeline buffer, which effectively decouples SCSI activity from the VME Bus. The SCSI port, acting as a full host adapter, can support seven SCSI peripherals with asynchronous transfer rates to 1.5M

bytes/sec. Either single-ended or differential drivers drive the port.

The printer port interfaces with a variety of parallel printers, including Centronics, Epson, IBM, and Citizen. You can configure the plotter via jumper to handle most high-speed, high-resolution, monochrome and color electrostatic plotters. The V/MIX 3210 is packaged on a single double-height VME Bus board. \$995 (OEM qty).

Interphase Corp, 2925 Merrell Rd, Dallas, TX 75229. Phone (214) 350-9000. TWX 910-997-6245.

Circle No 684

Get more out of your workstation.

Give your workstation the powerful output it deserves. Versatec electrostatic and thermal plotters deliver your drawings, maps, and charts faster, more reliably than any pen plotter.

Draw big, beautiful plots with high speed monochrome or color plotters in plot widths from 11 to 44 inches. Print as you plot using hardware character generators. Present your work on high quality paper and film media.

The right connection. Link your Sun, Apollo, MicroVAX or IBM PC/AT workstation directly with any Versatec plotter via fast parallel interfaces and optimized plotting software, or simultaneously receive plots from six nodes on your Ethernet® TCP/IP network with a Versatec Plot Server.

Versatec delivers more support. More interfaces. More standalone and embedded rasterizers. More experienced electrostatic and thermal plotter service. And more spares at more locations.

Circle our readers' service number or call toll-free 800/538-6477* for your copy of "How to get more out of your workstation."

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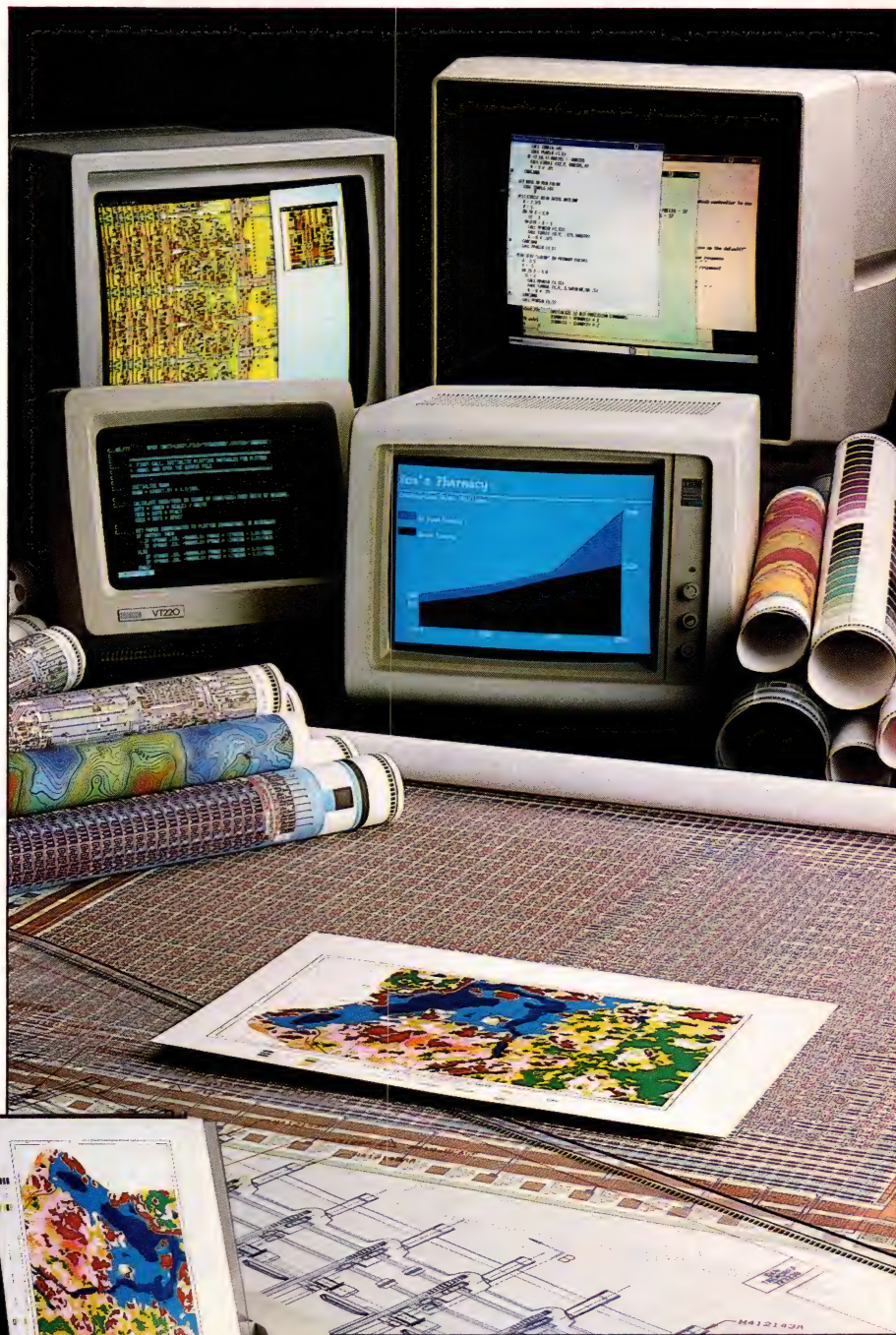


*In California, call toll-free 800/341-6060

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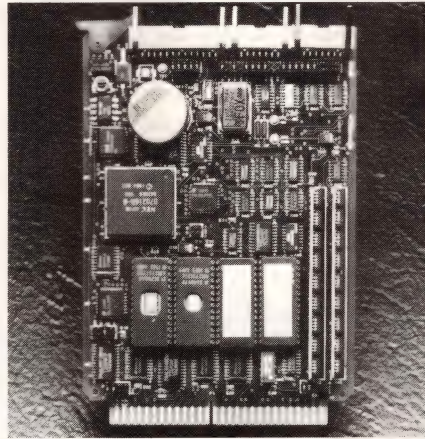
See us at SIGGRAPH

CIRCLE NO 130

Computers and Peripherals

Single-board computers bring 16-bit operation and PC-DOS to the STD Bus

The ZT 8816/8817 single-board computers implement the full 16-bit data-bus performance and bring the PC-DOS operating system to STD Bus-based test and control applications. The ZT 8816 features a 5-MHz NEC V50 microprocessor; the ZT 8817 features an 8-MHz version of the same CPU. Because of the NEC V50 μ P, you can have IBM PC/AT performance plus greater access to more peripheral devices. At the same time, both computers also conform to the STD Bus Manufacturer's Group STD-8088 specifications. The boards run STD-DOS V50 (an enhanced version of IBM PC-DOS) and existing IBM PC software programs, such as Lotus 1-2-3, Turbo



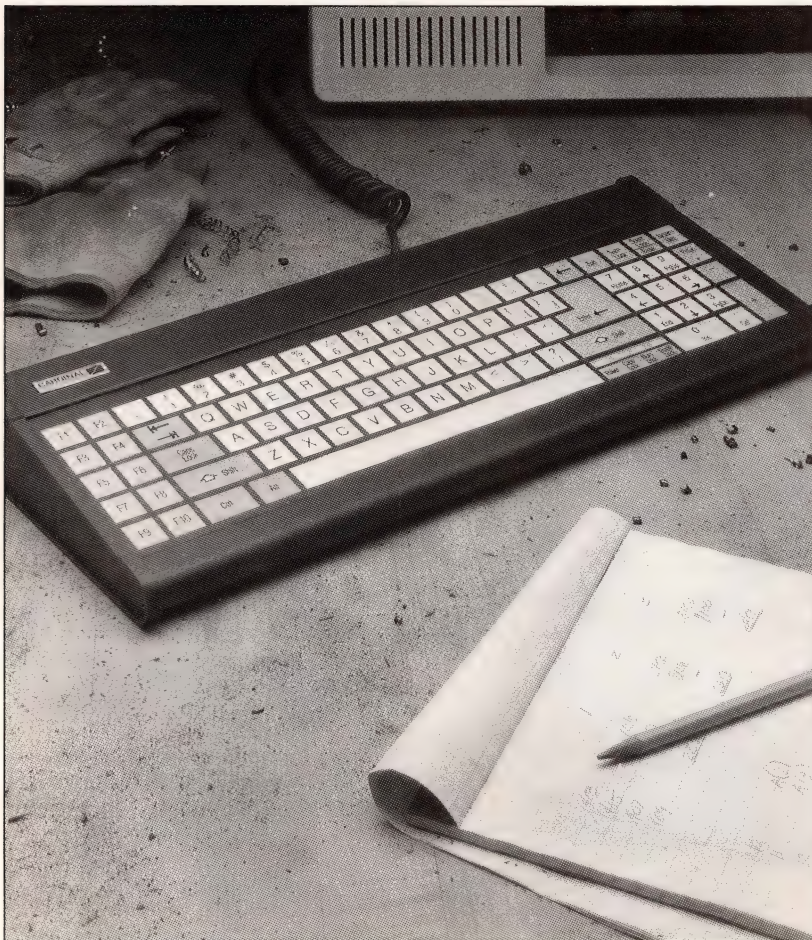
Pascal, and Flight Simulator on board. Each board contains 512k bytes of dynamic RAM, capacity for 256k bytes of PROM/RAM (four byte-wide sockets), and as much as

64k bytes of battery-backed static RAM.

I/O capabilities include two serial channels, three counter timers, and an interrupt controller. A DMA channel provides high-speed data transfers between memory and I/O. The ZT 8816/8817 also support DMA transfers initiated by external DMA controllers to and from the ZT 8816/8817 memory. They include a battery-backed, real-time clock and protection against ac and dc power failures. The ZT 8816/8817 cost \$995 and \$1025, respectively.

Ziatech Corp., 3433 Roberto Ct., San Luis Obispo, CA 93401. Phone (805) 541-0488. TLX 4992316.

Circle No 668



Works Hard Without Breaks.

The new Cardinal KB695 membrane keyboard goes wherever the work is—even into hostile environments that cause standard full-travel units to take frequent breaks for cleaning and service. For industrial controls, robotics, laboratory use, remote data entry, public access—wherever you need reliable, full-featured performance—Cardinal KB695 keyboards keep you on-line.

IBM compatible. A built-in auto-configuring capability allows you to plug in directly to IBM PC, XT, AT, and "clones". No special wiring or interfaces. And Cardinal KB695 keyboards give you all the keys and functions of a full-travel keyboard, so you're ready to go to work immediately.

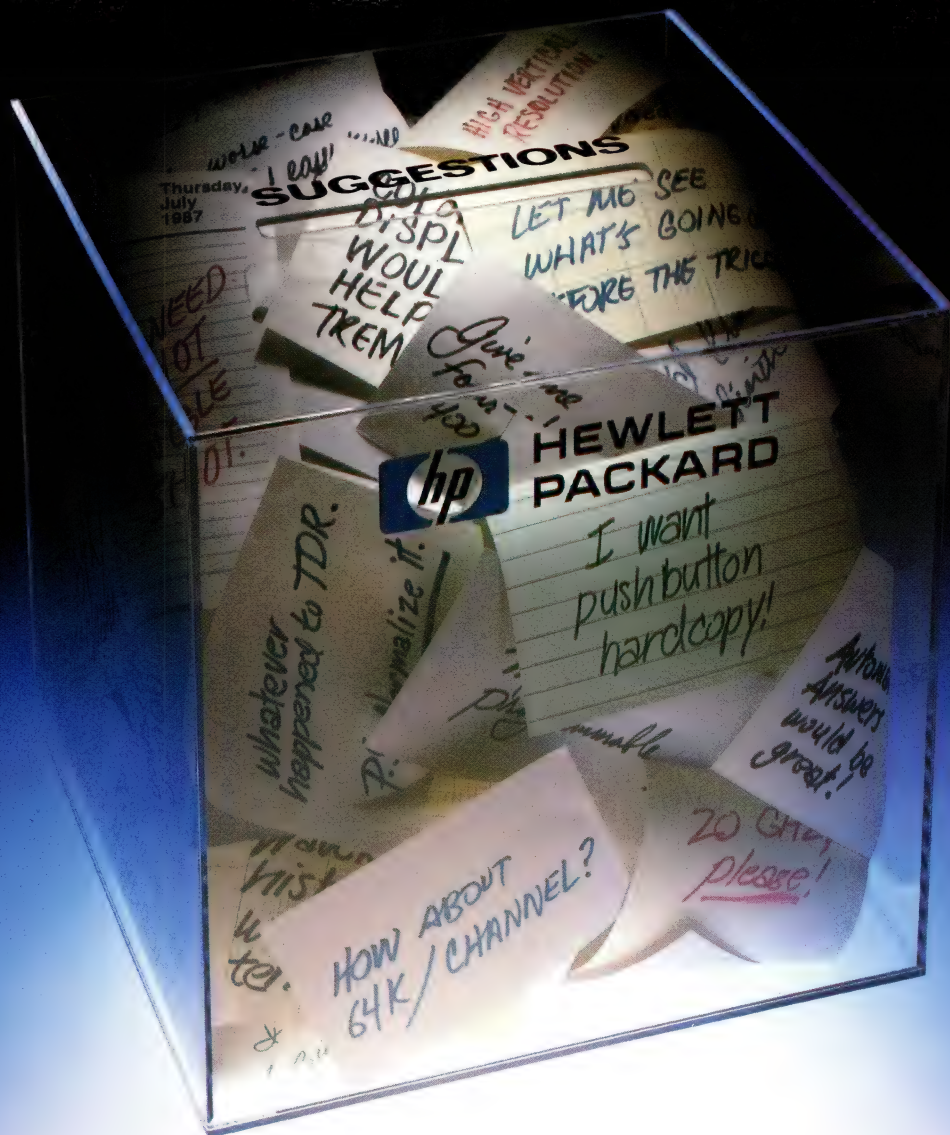
Tough but easy to use. Rugged flexible-membrane key switches feature finger-positioning overlays for positive feel and light-touch response. Dust, dirt, and other contaminants that can foul and "short" a full-travel keyboard can be quickly removed from the flat membrane surface with a simple wipe. Anodized housings resist corrosion and wear. And large, easy-to-read keypads are color-coded by function for easy operation—even in dimly-lit locations.

Call 800-722-0094 (717-295-6922 in PA) for more information or to order. Or write: Cardinal Technologies, Inc., New Holland Avenue, Lancaster, PA 17604-7628.

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you wanted in
digitizing oscilloscopes,



and we
took your advice...

...AGAIN.

Introducing HP's new high-perfo

You told us what would best meet your measurement needs.

So in '84 and '85 we brought you digitizing oscilloscopes with pioneering features like full programmability, 1 GHz repetitive bandwidth, color displays, automatic answers, single-shot pulse reconstruction, infinite persistence, and instant hardcopy output.

And now, we bring you the new HP 54111D/54112D/54120T series.

These high-performance digitizing oscilloscopes let you measure what you've never measured before, with superb accuracy and ease of use.

You'll find innovations

such as 20 GHz bandwidth, 4-channel simultaneous 400 MSa/sec with 64k memory per channel, time domain reflectometry (TDR) with normalization, 10 psec time interval accuracy, and more.

HP 54111D: the hot single shot.

The HP 54111D offers two simultaneous channels operating at up to 1 Giga-sample per second...allowing you to capture high-speed single-shot phenomena such as high-speed pulses, plasma discharge, high voltage arcing, high frequency bursts, laser pulses and high energy events.

You get the single-shot performance of analog storage oscilloscopes with all of the performance advantages of digitizing oscilloscopes.

The HP 54111D also offers a 500 MHz bandwidth, so it will perform admirably in a wide variety of repetitive as well as non-repetitive applications.

HP 54112D: 64,000 bytes times 4.

The HP 54112D offers you simultaneous 4-channel capture at 400 Megasamples per second with 64k of memory per channel. Just right for the long data streams found in serial data communication applications.

HP 54111D

- ☐ 1 Gigasample/sec digitizing rate
- ☐ 500 MHz repetitive bandwidth
- ☐ 250 MHz single-shot bandwidth
- ☐ 8k memory per channel
- ☐ 1 mV/div sensitivity

HP 54112D

- ☐ 400 Megasamples/sec digitizing rate
- ☐ 100 MHz repetitive or single-shot
- ☐ 4 simultaneous channels
- ☐ 64k memory per channel



rmance digitizing oscilloscopes.

Four simultaneous channels enhance critical timing measurements on multiple test points...single-shot. And the HP 54112D's four channels are always real-time correlated for every trigger occurrence.

In automated test, four channels with 64k memory per channel boost your throughput by capturing 256k of data simultaneously.

HP 54120T: excels in high-speed applications.

With its 20 GHz bandwidth and 10 psec accuracy, the HP 54120T lets you measure propagation delays of ICs or switching times of high-speed

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You get high sensitivity, resolution, and accuracy for repeatable time-interval and voltage measurements, with stability and ease-of-use comparable to lower-performance oscilloscopes.

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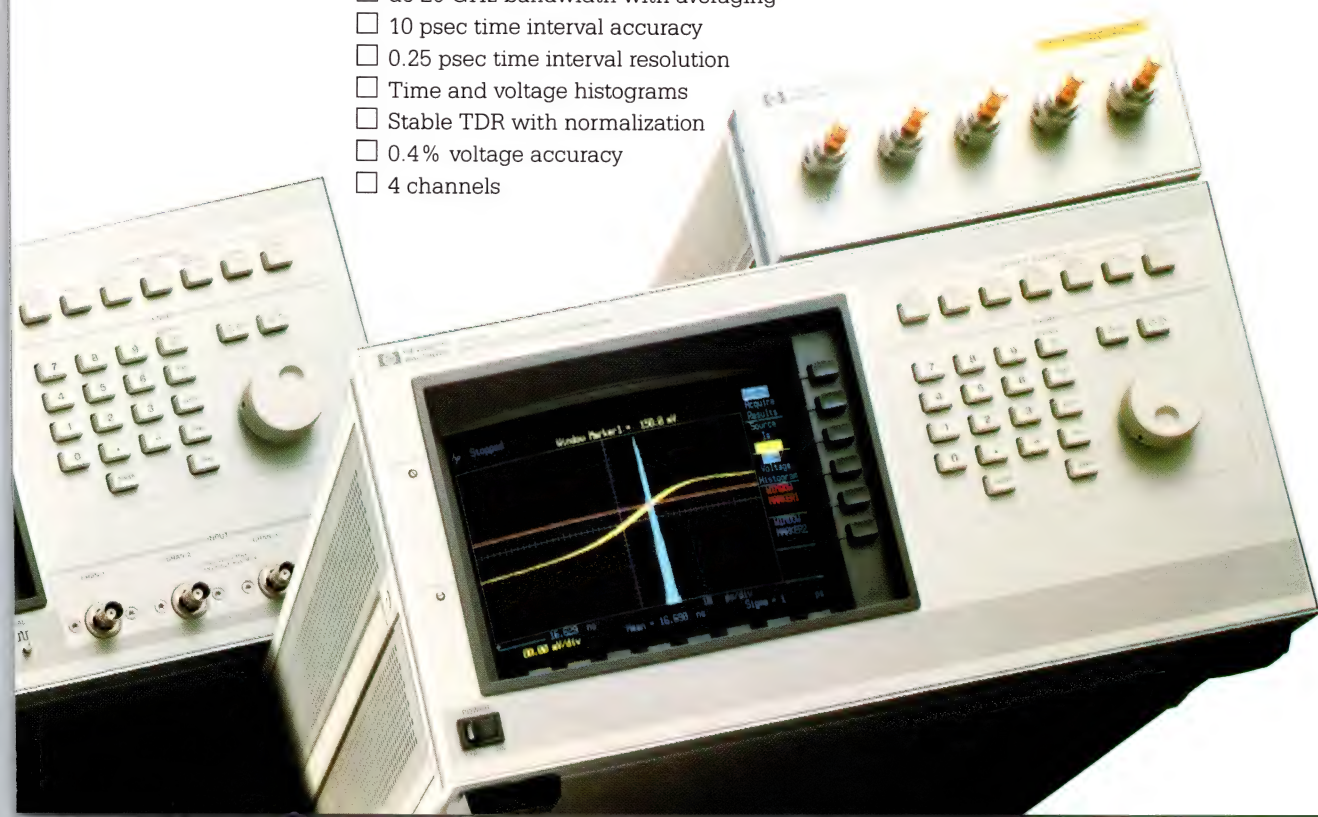
For more information on our new high-performance digitizing oscilloscopes, fill out and mail the postage-paid reply card today. Call us direct at **1-800-752-0900**. Or contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.



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PACKARD**

HP 54120T

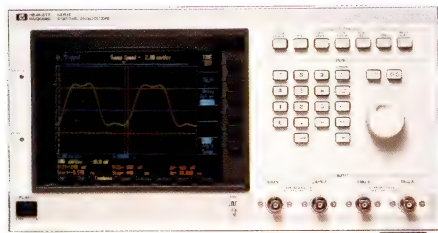
- ☐ dc-20 GHz bandwidth with averaging
- ☐ 10 psec time interval accuracy
- ☐ 0.25 psec time interval resolution
- ☐ Time and voltage histograms
- ☐ Stable TDR with normalization
- ☐ 0.4% voltage accuracy
- ☐ 4 channels



The specs you need, and the features you want.

In addition to their outstanding individual contributions, the new HP 54111D/54112D/54120T digitizing scopes offer you full programmability, automatic measurements, instant hardcopy output to printers and plotters, waveform storage, and multiple-color displays.

You also have HP's excellent reliability, documentation, and support to make you productive with your HP instrument quickly and ensure your satisfaction for years to come.



HP 54111D \$23,900.00*

VERTICAL:

Rep. bandwidth	500 MHz
S.S. bandwidth	250 MHz
Inputs	2 chan & 2 trig
Resolution	8 bit to 25 MHz, 7 bit to 100 MHz, 6 bit to 250 MHz
Sensitivity	1 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm

HORIZONTAL:

Digitizing rate (max)	1 GSa/sec
Resolution	10 psec
Pre-trigger viewing	YES

MEMORY:

Acquisition/chan	8k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm

Nonvolatile instrument setups	10
----------------------------------	----



HP 54112D \$22,900.00*

VERTICAL:

Rep. bandwidth	100 MHz
S.S. bandwidth	100 MHz
Inputs	4 chan & 1 trig
Resolution	6 bit to 100 MHz
Sensitivity	5 mV/div to 5 V/div
Coupling	ac, dc; 50 Ohm & 1 MOhm

HORIZONTAL:

Digitizing rate (max)	400 MSa/sec
Resolution	40 psec
Pre-trigger viewing	YES

MEMORY:

Acquisition/chan	64k
Waveform storage	2 pixel, 4 rep wfm, 4 ss wfm

Nonvolatile instrument setups:	10
-----------------------------------	----



HP 54120T \$27,850.00**

VERTICAL:

Rep. bandwidth	20 GHz
S.S. bandwidth	NO
Risetime	17.5 psec
Accuracy	0.4%
Inputs	4 chan & 1 trig
Resolution	12 bits
Sensitivity	1 mV/div to 80 mV/div
Coupling	50 Ohm

HORIZONTAL:

Accuracy	10 psec
Resolution	0.25 psec
Pre-trigger viewing	NO
Range	10 psec/div-1 s/div

MEMORY:

Acquisition/chan	0.5k
Waveform storage	2 pixel (volatile), 4 rep wfm (nonvolatile)

Nonvolatile instrument setups:	10
-----------------------------------	----

TDR

Pulse source	
Amplitude	0-200 mV
Risetime	35 psec
Flatness	1%
Normalization	YES
Waveform histograms	YES

*U.S. list price only.

Varies according to options selected.

**U.S. list price only.

Includes both the HP 54120A and HP 54121A.

Specifications subject to change without notice.



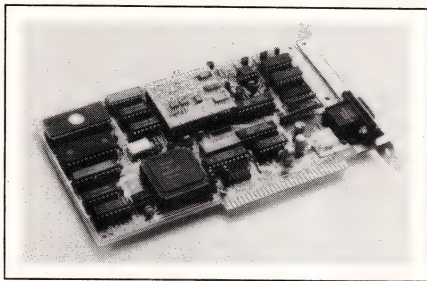
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stop
asking
"What if..."

Computers and Peripherals

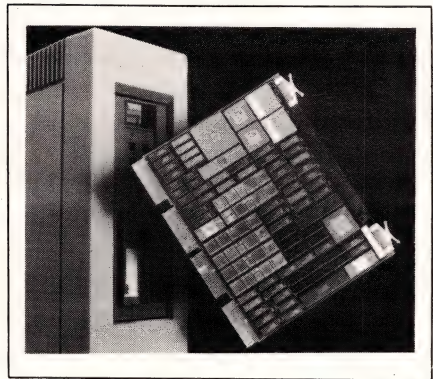


TOUCH CONTROLLER

The 4003 Touch Controller board adds capacitive touch-input capability to the IBM PC and compatibles. The 4003 fits into an IBM PC bus slot and attaches to one of the company's touchscreen monitors via a single cable connected to the controller. The board requires no manual adjustments, has a standard scaled resolution of 256×256 pixels, and has drivers optimized for the MS-DOS environment. It also features skew compensation for accurate registration of the touchscreen image; write default for storage of touch-system parameters in nonvolatile RAM; specification of touch-response rates from 50 to 500 msec; optional display of first, repeated, and last touch; and ESD protection. \$295 to \$395 (OEM qty) for controllers paired with 9- to 25-in. touchscreens.

Interaction Systems Inc, 130 Lincoln St, Brighton, MA 02135. Phone (617) 789-5900. TLX 753582.

Circle No 427



ARRAY PROCESSOR

The MicroMSP-4 is a single-board floating-point array processor for the Q22 bus of LSI-11 and MicroVAX computers. The vector-

processor section is a complete 32-bit floating-point computer with a 100-nsec cycle time and two static-RAM vector memories. You can link dual address generators (2901 processors) to generate 32-bit addresses or operate on 32-bit data. The control-processor section is a 20-MHz 68020 microprocessor with random access to the multiport memory. The 68020 performs block data movement and DMA control. It can also control off-board A/D converters and other external devices. The host-interface section performs DMA transfers between the board and the host memory.

The control processor, vector processor, and host interface share the Multiport Memory System section. The MicroMSP-4 features a 32-bit floating-point format and a 20M-flops computation rate. It can perform a 1024-point complex FFT in 4 msec and a 512×512 -point, complex 2-D FFT in 2.5 sec. It also performs FIR-filter design with 100-nsec taps. \$5950 (100). Delivery, 90 days ARO.

Computer Design & Applications Inc, 411 Waverly Oaks Rd, Waltham, MA 02154. Phone (617) 647-1900. TLX 922521.

Circle No 428



DRIVE TESTER

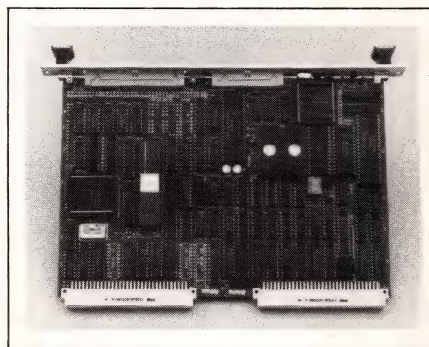
The PR4042 portable disk-drive qualifier is a universal tester for SMD and ESMD disk drives. It acts as a controller to determine whether a drive will work properly with its own controller. Its standard format has a 32-bit error-correction code and a 24M-bit data-transfer rate. You can test multiple drives in daisy-chain configurations.

The tester is software controlled,

and it can monitor and diagnose drive and interface problems, format disk drives off-line, align heads, and verify disk packs. When used with a multiplexer, the PR4042 can handle as many as 16 units simultaneously. You can operate the tester remotely via phone modem and terminal. You can use the vendor's PC Link software package with the PR4042 to collect, manipulate, and store test data on IBM PC-family and compatible computers. PR4042, \$11,000; PC Link, \$500.

Pioneer Research, 1745 Berkeley St, Santa Monica, CA 90404. Phone (800) 223-1745; in CA, (800) 848-1745. TWX 910-343-6249.

Circle No 429



VME BUS ADAPTER

The Rimfire 3500 VME Bus adapter interfaces to as many as seven peripheral devices with standard or vendor-unique SCSI commands. The board, which provides communication between SCSI devices and a VME Bus computer system, also interfaces to as many as four IBM PC-compatible floppy-disk drives. The 3500 transfers data across the SCSI bus asynchronously at 1.5M bytes/sec max, and synchronously at 4M bytes/sec max. The board also uses a 32-bit-wide FIFO memory to achieve a VME Bus burst rate of 30M bytes/sec.

A scatter/gather transfer technique allows complete data blocks to reside in memory segments of any size and at discontinuous locations. Software support for the board includes drivers for Unix System V and BSD 4.2. Both single-ended and

Computers and Peripherals

differential SCSI-bus transceiver options are available. The board is a single-slot, double-height Eurocard. \$1395.

Ciprico Inc, 2955 Xenium Lane, Plymouth, MN 55441. Phone (612) 559-2034. TWX 910-240-0585.

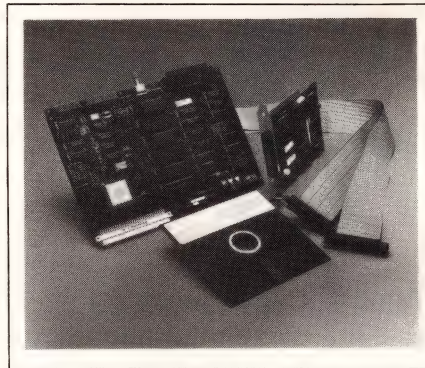
Circle No 430

Force Computers Inc, 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410.

Circle No 431

Force Computers GmbH, Daimlerstrasse 9, 8012 Ottobrunn, West Germany. Phone (089) 60091-0. TLX 524190.

Circle No 432



DEVELOPMENT SYSTEM

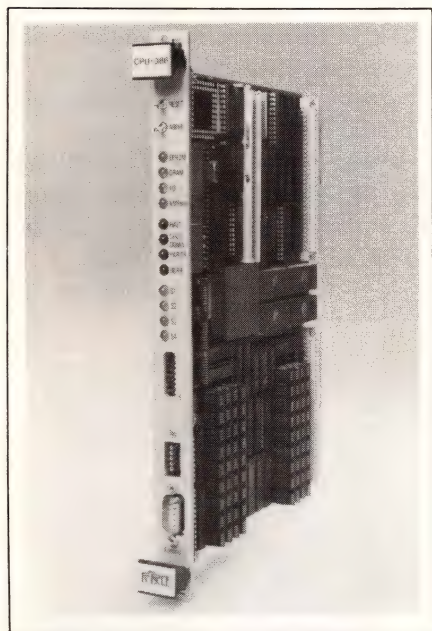
The DSP56000ADS is an application-development system for DSP56000/DSP56001-family products. The system consists of three parts: an Application Development Module (ADM) board, an IBM PC-bus interface board, and an MS-DOS-based user-interface program that runs on the IBM PC. The program allows you to control as many as eight ADMs simultaneously. You can execute DSP programs in real time, or you can execute single or multiple instructions. This way, you can display registers and memory-block contents. You can place as many as 99 breakpoints in ADM program memory. The hardware provides 8k bytes of RAM and 1k to 4k words of user-programmable ROM. The board provides access to all DSP56001 pins via a standard 96-pin Eurocard connector, so you can use standard Eurocard prototype boards to develop products. Two additional connectors provide access to the DSP56001 on-chip peripheral circuits. The development system is compatible with the DSP56000SASMA assembler/simulator software package. \$3000.

Motorola Inc, Microprocessor Products Group, 6501 William Cannon Dr W, Austin, TX 78735. Phone (512) 440-2039.

Circle No 434

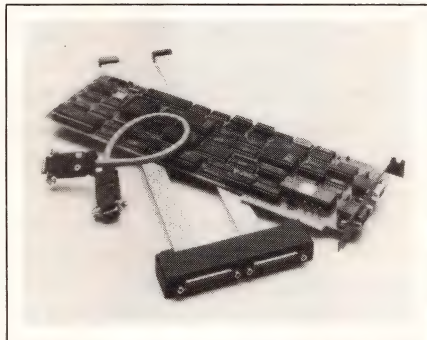
GRAPHICS SUBSYSTEM

The CGS-4600 graphics subsystem plugs into the DEC MicroVAX II computer's Q Bus, creating a stand-alone graphics workstation. Its



80386 FOR VME BUS

The CPU-386 is a zero-wait-state engine that's based on the 80386 microprocessor running at 16 MHz. This 32-bit single-board computer for the VME Bus is compatible with programs that run on Intel's iAPX 8086/80286/80386 family. It provides four sockets for JEDEC memory devices (EPROMs and EEPROMs), 3 serial I/O ports, a time-of-day/real-time clock/calendar, two 16-bit and three 8-bit counter/timers, and a socket for the installation of an 80387 coprocessor. It comes with a total of 2M bytes of parity-checked dynamic RAM and with Forcebug/386, a debugging package with full 80386 and 80387 assembler/disassembler capabilities. Because it pipelines instructions and data, the CPU-386 offers 3 to 4 MIPS sustained performance. When equipped with an 80387 coprocessor, the CPU-386 can achieve 1.8M Whetstones/sec. \$5775.



COMMUNICATOR CARD

The AST-220 controller card fits into the IBM PC, PC/XT, PC/AT, and compatible computers, providing direct or remote connection to DEC VAX or MicroVAX systems and allowing the PCs to emulate DEC VT220 terminals. The board incorporates two RS-232C ports, which can be connected either to two different ports on a DEC host or to two different DEC hosts. Each port can be driven at 19.2k baud max.

System software is downloaded onto the AST-220, which has an 80186 processor with 128k bytes of RAM, so only 16k to 20k bytes of the PC's memory is used. The system software provides a multi-tasking operating system with full windowing features. Five windows let you work in a DOS window while observing applications running on the DEC host. The full VT220 emulation includes 80- or 132-character column displays, smooth or jumping scrolling, and double-width and double-width/double-height characters. \$595.

AST Research Inc, 2121 Alton Ave, Irvine, CA 92714. Phone (714) 863-1333.

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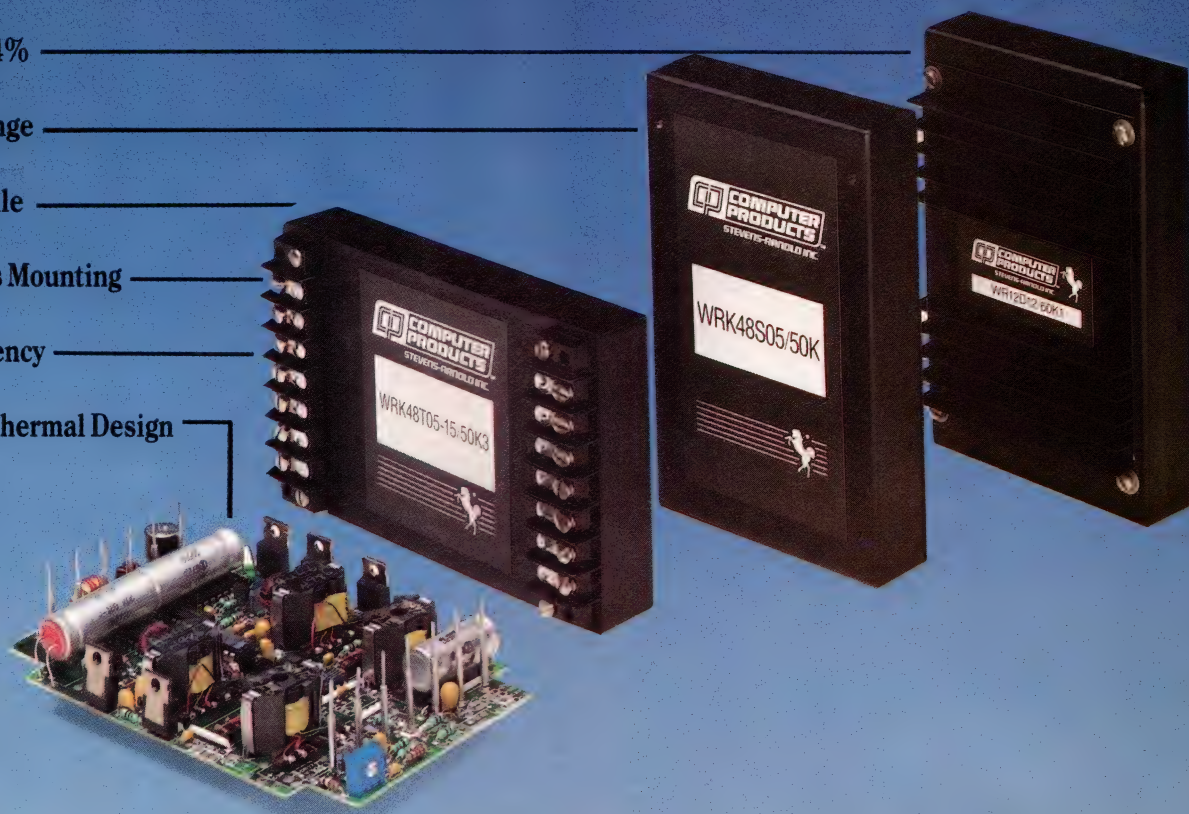
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				Harris: 80C86 80C88	NEC: V20 V30
				National: NSC800	Signetics: 8X300 8X305

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*Assumes EZ-PRO Development Station connected to MSDOS host.

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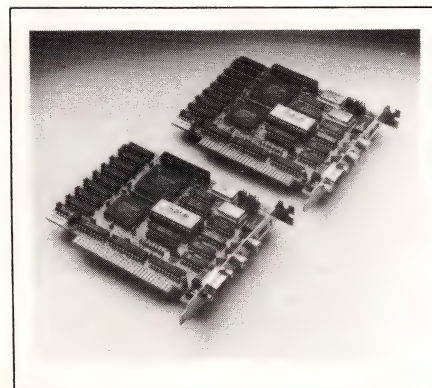
Computers and Peripherals



color graphics offer 1280×1024-pixel resolution. The CGS-4600 is available either as a complete subsystem (including color monitor, keyboard, mouse, and digitizer) or as just a graphics engine. The card has a 68020 μ P that executes graphics-control commands and a DSP32 processor that executes floating-point operations. The card also includes a high-speed D/A converter, which handles look-up table functions. You can display 256 colors from a palette of 16.7 million. Residing in the graphics engine is a software command set based on the emerging Computer Graphics Interface (CGI) standard. The complete CGS-4600 subsystem costs \$6995 with a 15-in. monitor and \$9495 with a 19-in. monitor. The graphics-engine card costs \$3995.

CalComp Display Products Div,
65 River Rd, Hudson, NH 03051.
Phone (603) 885-8280.

Circle No 435



GRAPHICS BOARD

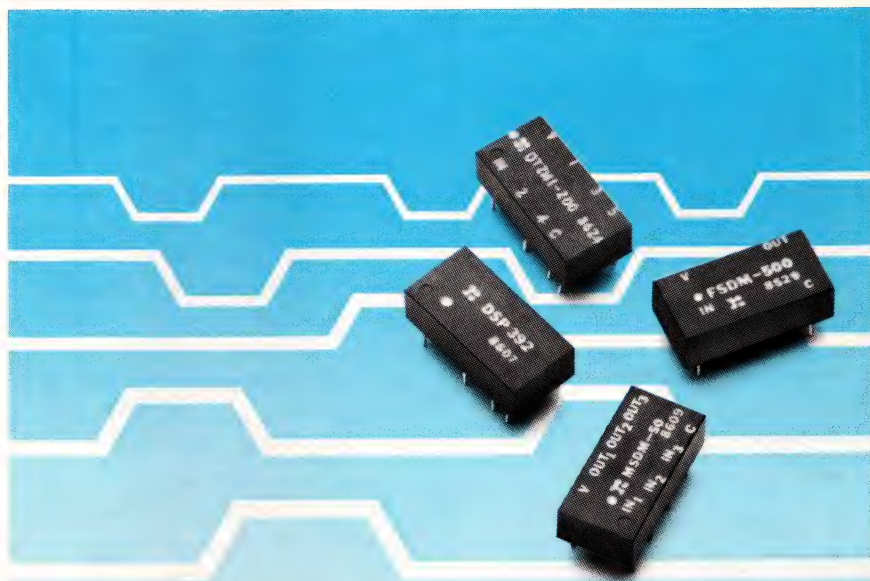
The EGA Master 480 and 800 are half-size IBM PC boards that are completely software compatible with the IBM EGA, CGA, and

MDA; Hercules; and Plantronics graphics modes. The EGA Master 800 provides 800×600-pixel resolution in 16 colors on a multiple-scanning-frequency monitor, such as the NEC Multisync or equivalents. The EGA Master 480 provides 640×480-pixel resolution in 16 colors on the same monitors. Drivers for AutoCAD, GEM, and Microsoft Win-

dows come with both boards. Either board can display Lotus 1-2-3, Symphony, and DOS applications in as many as 132 columns×44 lines. EGA Master 480, \$495; EGA Master 800, \$595.

Tecmar Inc, 6225 Cochran Rd,
Solon, OH 44139. Phone (216) 349-0600. TLX 466692.

Circle No 437



PERFECT TIMING!

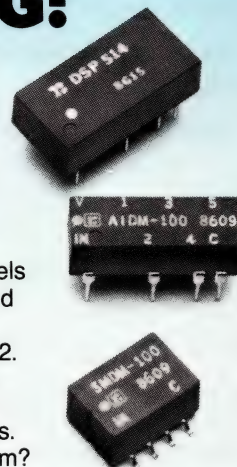
Rhombus has created some brand new TTL delay modules — just when you needed solutions to your circuit-timing problems.

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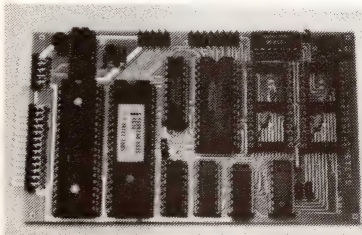
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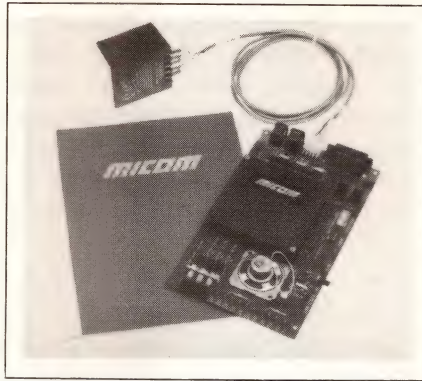
Salem, Oregon

97302

(503) 581-6570

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Computers and Peripherals



DIAL-UP MODEM

The M3124EH, type M2, is a 3-speed dial-up-modem module that measures 3.9×3.9×0.65 in. Its small size lets the modem fit easily into PCs, terminals, printers, and test equipment. The modem features the Hayes AT autodialing command set and the MNP networking error-correction protocol through class 4. It can communicate with any dial-up modem that uses CCITT V.22 bis, CCITT V.22, Bell 212, or Bell 103A/T specifications.

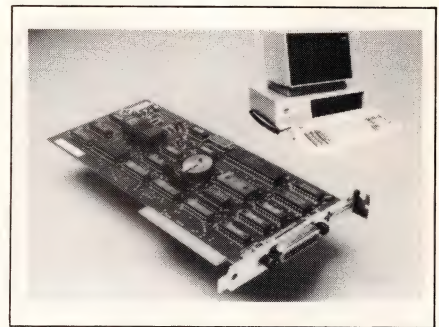
The module provides adaptive equalization by monitoring the telephone line 300 times a second and making adjustments to an equalizer circuit. The MNP protocol allows the full-duplex transmission of data packets in one direction while acknowledgments flow simultaneously in the other direction. \$499. The M3124EH-E1 evaluation kit, which comprises a pc-board-mounted M3124EH (type M2) module and a separate dc power supply, costs \$699.

Micom Systems Inc, 4100 Los Angeles Ave, Simi Valley, CA 93063. Phone (805) 583-8600.

Circle No 438

GPIO CONTROLLER

The 488-PC1 plug-in card for the IBM PC/XT, PC/AT, and compatibles turns these computers into IEEE-488 (GPIO) bus controllers able to operate as many as 14 instruments. The 488-PC1 incorporates all the necessary software drivers and all IEEE-488 controller functions. The card is therefore independent of

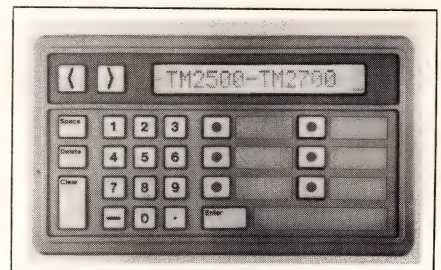


the host memory and operating system. Only user test and measurement programs reside in the host RAM or on disk. A battery-backed real-time clock is standard.

You can change the standard mnemonics of the GPIO command set to words in any spoken or programming language. The standard card interfaces to IBM Basic, BasicA, and compiled Basic; other versions interface to C and Turbo Pascal. It transfers data at as much as 67k bytes/sec by using program I/O and as much as 300k bytes/sec by using DMA. The bus drivers are stored in an 8k×8-bit EPROM; an onboard, 2k×8-bit static RAM offers extra working space. The board is powered from the host and draws 600 mA at 5V dc. \$395.

ICS Electronics Corp, 2185 Old Oakland Rd, San Jose, CA 95131. Phone (408) 432-9009.

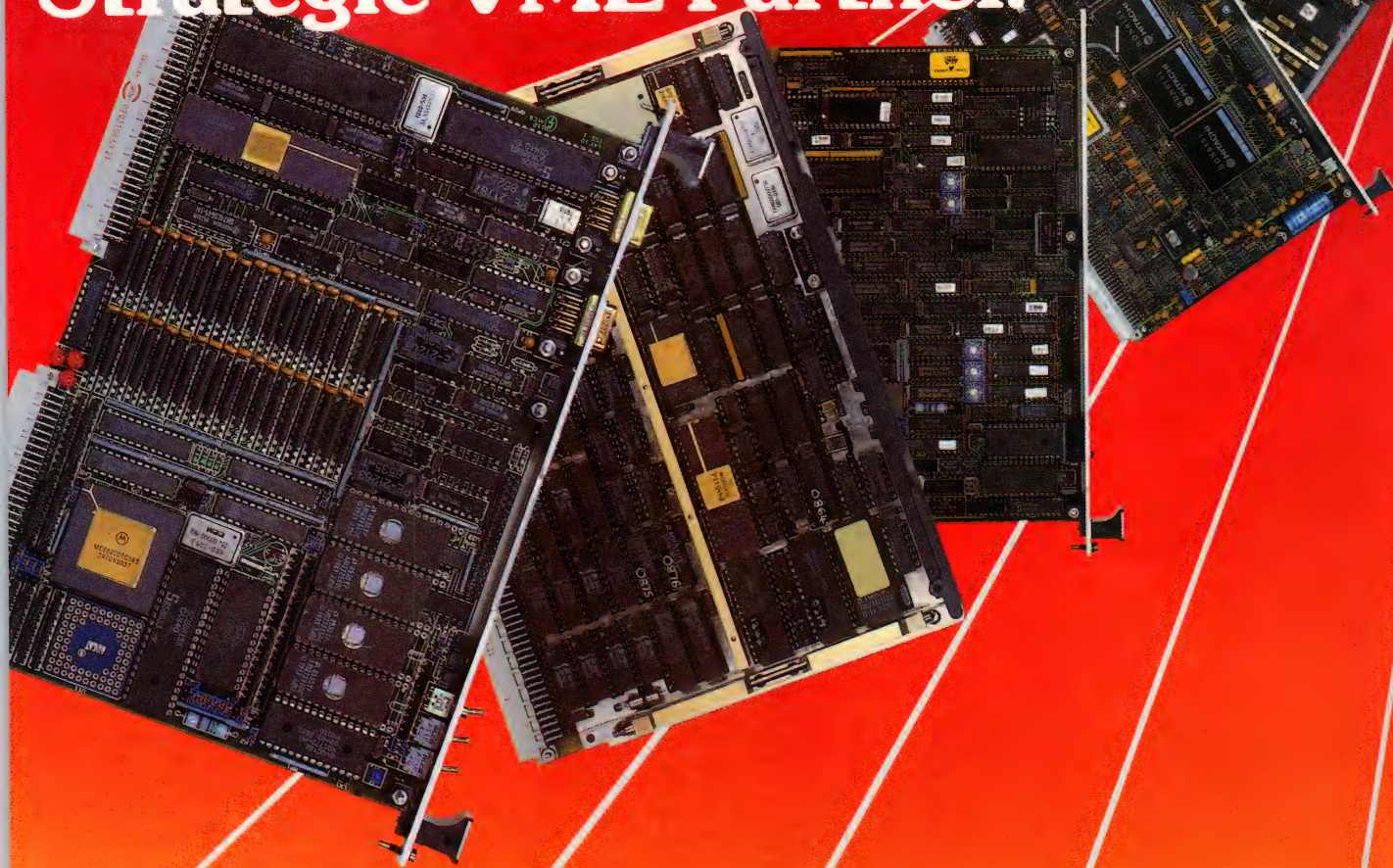
Circle No 439



INTERFACE TERMINALS

The TM2500 and TM2700 are low-cost, compact data-entry and -display terminals. The TM2500 communicates over an RS-232C interface; the TM2700 uses an RS-422 interface. The company recommends the TM2700 for electrically noisy environments and applications in which communication

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Germany Bahnhofstraße 38, 6090 Rüsselsheim (061 42) 6 80 04



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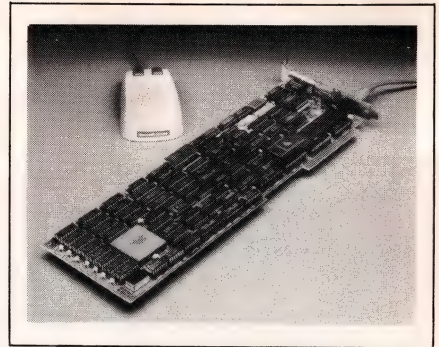
Computers and Peripherals

distances measure more than 50 ft. Each terminal weighs 10.5 oz and is enclosed in a 4.0×7.0×1.0-in. case. Their silicone-rubber numeric keypads each have 24 widely spaced keys. Six of the keys are programmable, back-lit function keys that provide prompts to you from the host computer. Each terminal has a 16-character LCD display that can

be scrolled left or right through an 80-character buffer. The terminals require 5V dc or 7.5 to 10V dc at 250 mA max (for the TM2500) or 350 mA max (for the TM2700). TM2500, \$195; TM2700, \$210 (100).

Burr-Brown Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666941.

Circle No 440



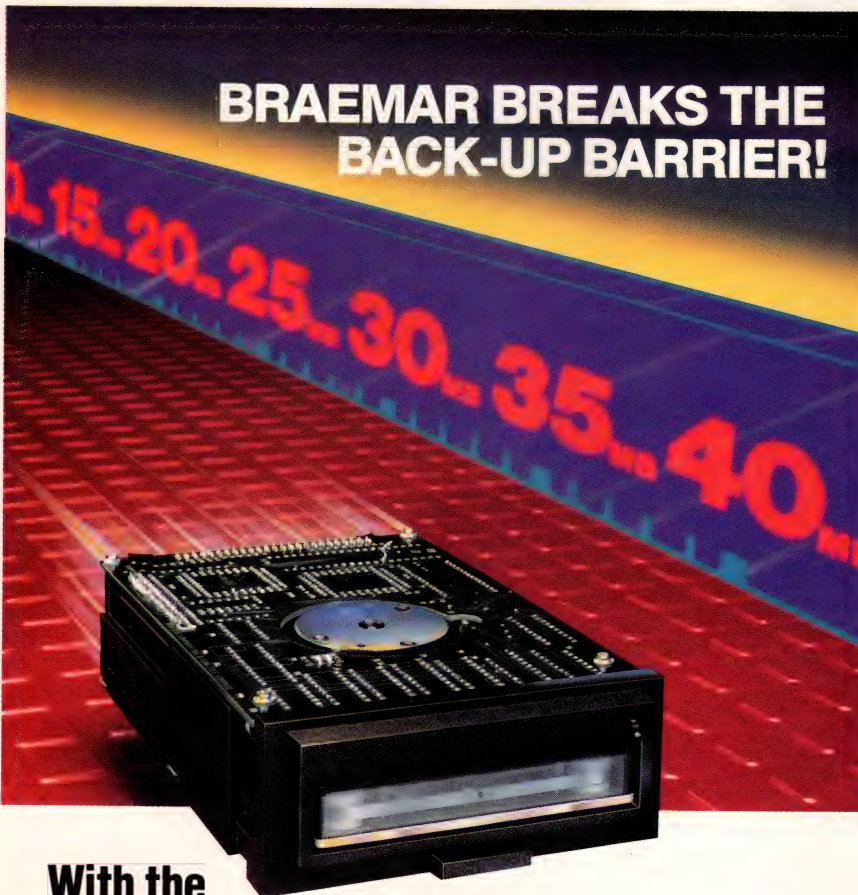
GRAPHICS CONTROLLER

The Desktop 1280 is a monochrome graphics controller for desktop-publishing applications. The controller, a plug-in board for the IBM PC/XT, PC/AT, and compatibles, is based on the Intel 82786 graphics coprocessor. It offers a character-drawing rate of 10,000 characters/sec and a line-drawing rate of 1.25 million pixels/sec. It offers 1280×960-pixel resolution and can simultaneously display two pages of 8½×11-in. text on a CRT screen. Its 82786 chip relieves the host of graphics and text-handling tasks.

It can run any software written for use with Microsoft's Windows, Digital Research's GEM, and IBM's Color Graphics Adapter (CGA). It can also run the MS-DOS versions of such software packages as Aldus's Pagemaker and Ventura Software's Ventura Publisher. A Microsoft InPort mouse interfaces directly to the board. The board can store previously calculated fonts in local display memory for fast access. \$1295.

Verticom Inc, 545 Weddell Dr, Sunnyvale, CA 94089. Phone (800) 433-5760; in CA, (408) 747-1222. TLX 754044.

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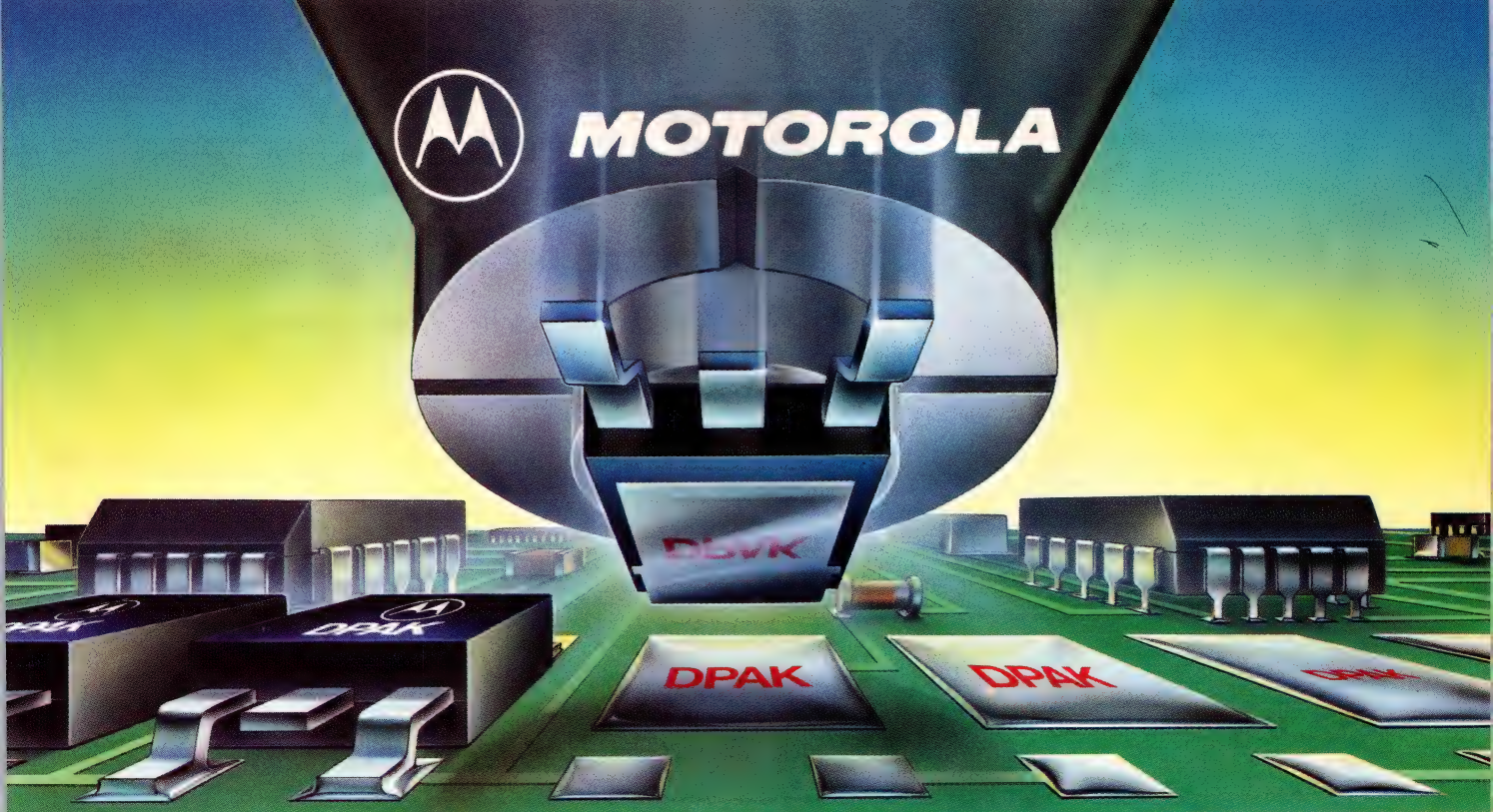
CIRCLE NO 22

CPU CARD

Incorporating a 10-MHz 68010 μ P, a 68451 MMU, a 68881 floating-point math coprocessor, a 68440 DMA controller, and 2M or 4M bytes of dual-ported RAM, the TSVME 106 VME Bus CPU card provides a single-board environment for the Unix System V operating system. The board also has 128k bytes of

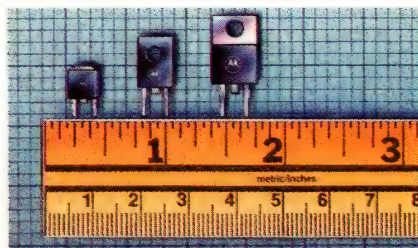


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MURD320	MBRD350	MJD31/32C	MJD200	MTD4P06
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MURD620CT	MBRD640CT	MJD44E	MJD13003	MTD10N05E
	MBRD650CT	MJE44E3*	MJD2955	
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*Darlington

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Computers and Peripherals

EPROM space, which supports a debug monitor. Its interfaces include four independent RS-232C ports on the front panel, a Centronics interface, and a 1.5M-byte/sec SCSI interface. The board's VME Bus interface has a 4-level bus arbiter, a watchdog timer, an interrupt handler and programmable interrupt requester, and bus-time-out

logic. The board also has a battery-backed real-time clock/calendar. In addition to supporting Unix, the TSVME 106 supports the company's TSVME 791 Unix/pSOS link software, which allows you to integrate a real-time operating system in the Unix operating system. From Fr fr 27,000 to Fr fr 37,000.

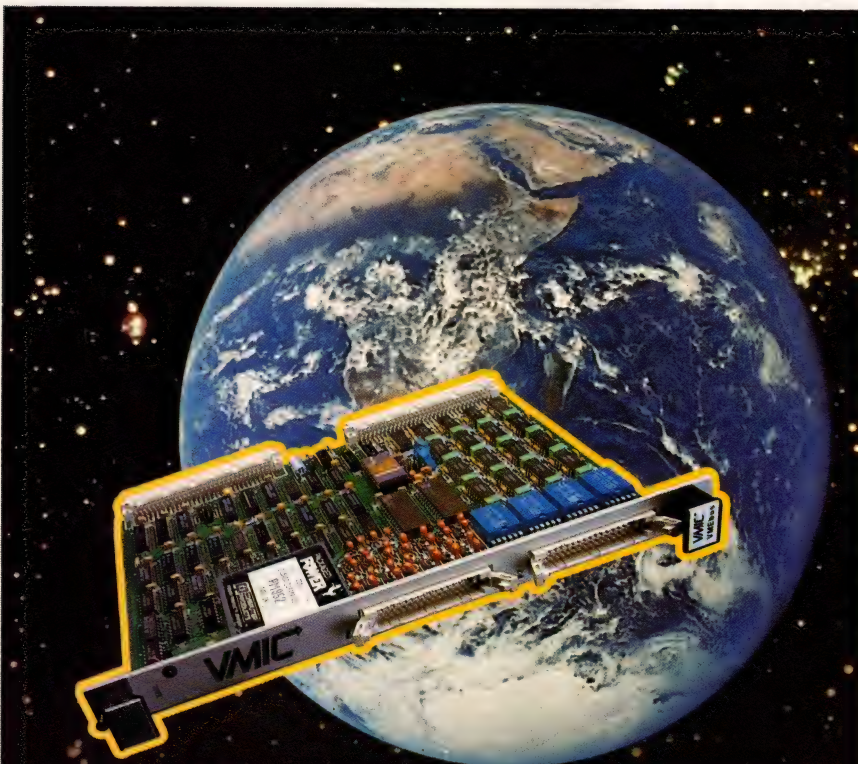
Thomson Semiconducteurs, Mi-

crosystems Div, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

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Thomson Components-Mostek Corp, 7950 E Redfield Rd, Scottsdale, AZ 85260. Phone (602) 951-2900.

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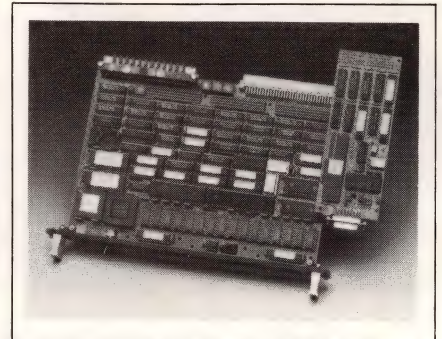
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VMIC VME

Photo courtesy of NASA



I/O BOARD

The double-Eurocard IBAM board for VME Bus systems is a μ P-based board into which you can plug as many as three piggyback I/O modules. The board has a 10-MHz 68010 μ P, 2M bytes of dual-ported RAM, sockets for EPROM firmware, a serial I/O port, and a 7-level interrupt handler. Semaphore registers and mailbox RAM areas allow for communication between processors in multiprocessor systems. In addition to its VME Bus interface, the board also has a VSB (VME subsystem bus) master/slave interface. The plug-in piggyback cards available for the board include interfaces for Ethernet/CheaperNet, MAP, and X.25 communications networks.

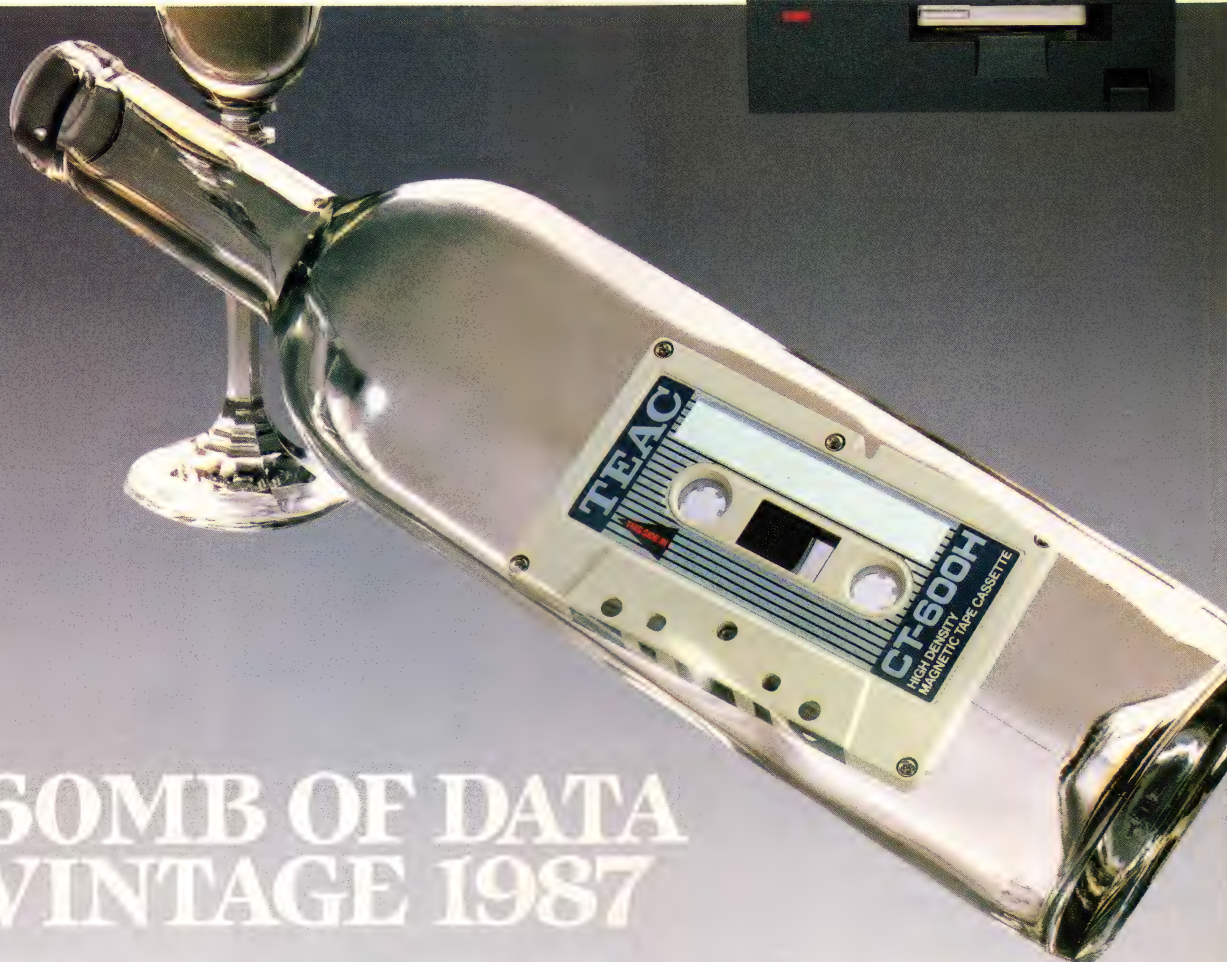
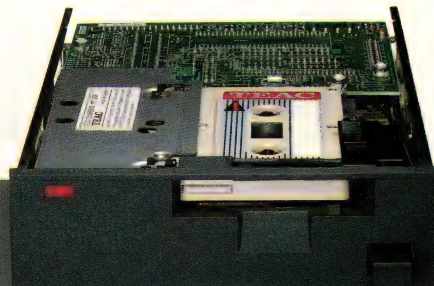
To facilitate the design of custom interface cards, the vendor provides a complete specification for the piggyback interface in the board's manuals. Software tools running under OS-9 or Unix are available for developing application programs. The IBAM board, \$1500; plug-in interface cards, from \$500 to \$1000.

Eltec Elektronik GmbH, Galileo-Galilei-Strasse 11, 6500 Mainz, West Germany. Phone (06131) 50630. TLX 04187273.

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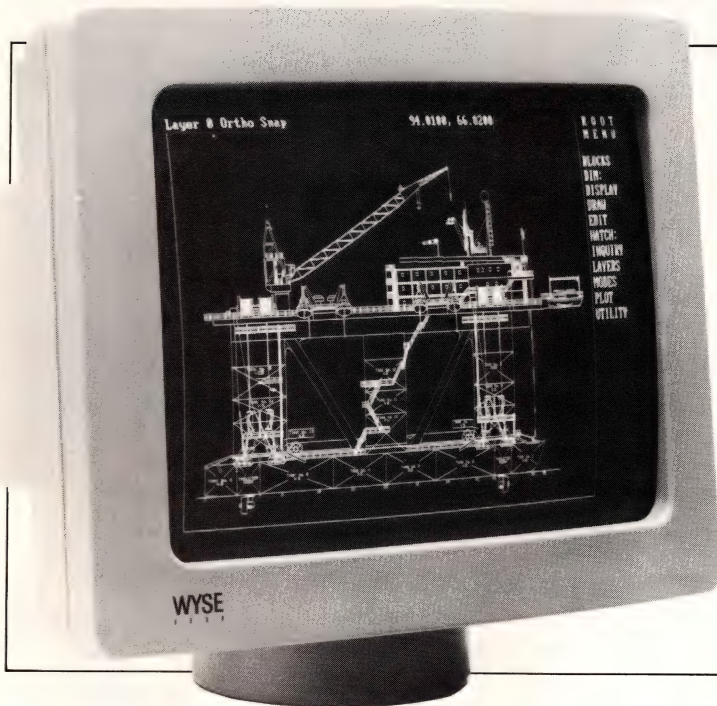
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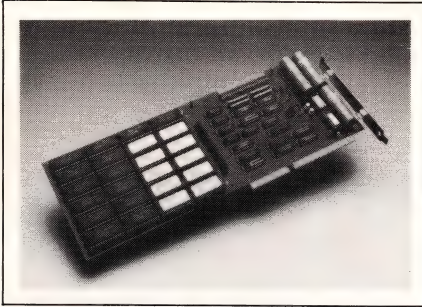
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Computers and Peripherals



SILICON DISK

The KAT-PRE add-in board for the IBM PC/AT and compatible computers allows you to run MS-DOS and MS-DOS-based application programs without using mechanical disk drives. The board can support as much as 1.2M bytes of EPROM. A plug-in programming module allows you to burn the operating-system and application programs into the EPROMs without removing them from the board. For data storage, the board has 384k bytes of battery-backed CMOS RAM, which you can optionally expand to 2.5M bytes. You can access both the EPROM and RAM areas of the board as though they were logical disk drives. A version with 512k bytes of EPROM and 384k bytes of RAM costs DM 1950.

Kontron Messtechnik, Oskar-von-Miller-Strasse 1, 8057 Eching, West Germany. Phone (08165) 77611. TLX 526719.

Circle No 444

Kontron Electronics Inc, 633 Clyde Ct, Mountain View, CA 94039. Phone (415) 965-7020. TWX 910-378-5207.

Circle No 445



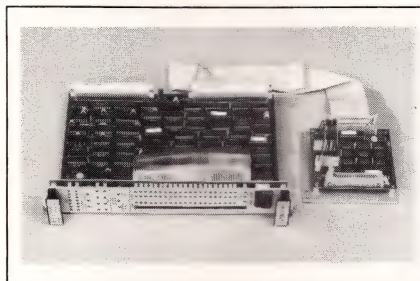
PHOTOPLOTTER

Although it's comparable in price to

a pen plotter, the DP-1545 photoplotter can produce high-precision artwork on film or can operate as a conventional 4-pen plotter. It accepts photographic materials having dimensions as large as 700×480 mm, and it has a plotting area of 550×395 mm. The positional resolution over the plotting area is 8 μ m, and the placement accuracy at 20°C is ± 50 μ m. The photo head has four aperture settings and produces four line widths. You can select from as many as 94 firmware-controlled standard drawing symbols. An optional daylight cubicle allows you to operate the photoplotter without requiring darkroom facilities. The DP-1545 operates via an RS-232C interface and accepts Gerber 6000 and extended HP-GL plot instructions. Photoplotter, Swiss fr 36,000; 4-pen head for ink and ballpoint pens, Swiss fr 2200; daylight cubicle, Swiss fr 5200.

Glaser AG, Hölzliwisenstrasse 4, 8604 Volketswil, Switzerland. Phone (01) 9455444. TLX 57885.

Circle No 447



VME BUS ANALYZER

Easing VME Bus systems integration, the CVMEOM1 bus-ownership monitor indicates which slot in a Revision-B or -C VME Bus system contains the active bus master, interrupt handler, and responding interrupter. The necessary monitoring of the bus-grant and interrupt-acknowledge daisy-chain signals is transparent to system operation. The bus-ownership monitor also provides outputs that allow you to assess the extent to which each master utilizes the bus. The other arbitration and interrupt signals it

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Computers and Peripherals

monitors include the interrupt-handler response level and the bus-grant signal generated by the system's bus arbiter.

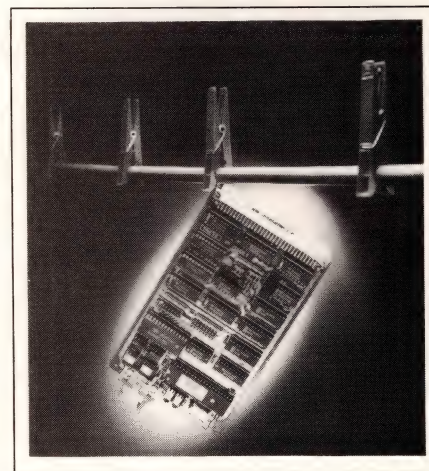
The bus-ownership monitor also displays other conditions, including a pending change of bus ownership, bus-arbiter timeouts, and arbitration lock-ups. The bus-ownership module, complete with its front

panel and indicators, normally occupies two adjacent VME Bus slots, but you can detach the front panel and operate it in a single slot. The monitor also includes intercept modules that can intercept the bus-grant and interrupt-acknowledge daisy chains. Around \$3000.

Concise Technology, 227a Aylesbury Rd, Bierton, Aylesbury,

Bucks HP22 5DS, UK. Phone (0296) 81483.

Circle No 448



NETWORK CARDS

The SNETS and SNETM are single-Eurocard boards that provide an interface between STE Bus systems and Bitbus networks. Both boards are based on Intel's 8044 Bitbus processor and can operate as Bitbus masters or slaves. The SNETS board operates as an STE Bus slave; an STE Bus CPU controls the SNETS boards via its I/O-mapped slave interface. The SNETM can operate as an STE Bus master or as a stand-alone Bitbus node processor.

In STE Bus master or stand-alone mode, commands sent via the Bitbus allow you to read or write to STE Bus locations or local I/O-port locations. As a result, for simple control applications, you don't need to write firmware for the SNETM board. For stand-alone applications, an I/O connector with 16 digital I/O lines allows you to interface the board to the company's signal-conditioning boards. Both the SNETS and SNETM boards have optical isolation in the Bitbus data and transceiver control lines, and by adding an additional isolated 5V power supply, you can achieve complete isolation from the Bitbus network. SNETS, approximately £200; SNETM, approximately £250.

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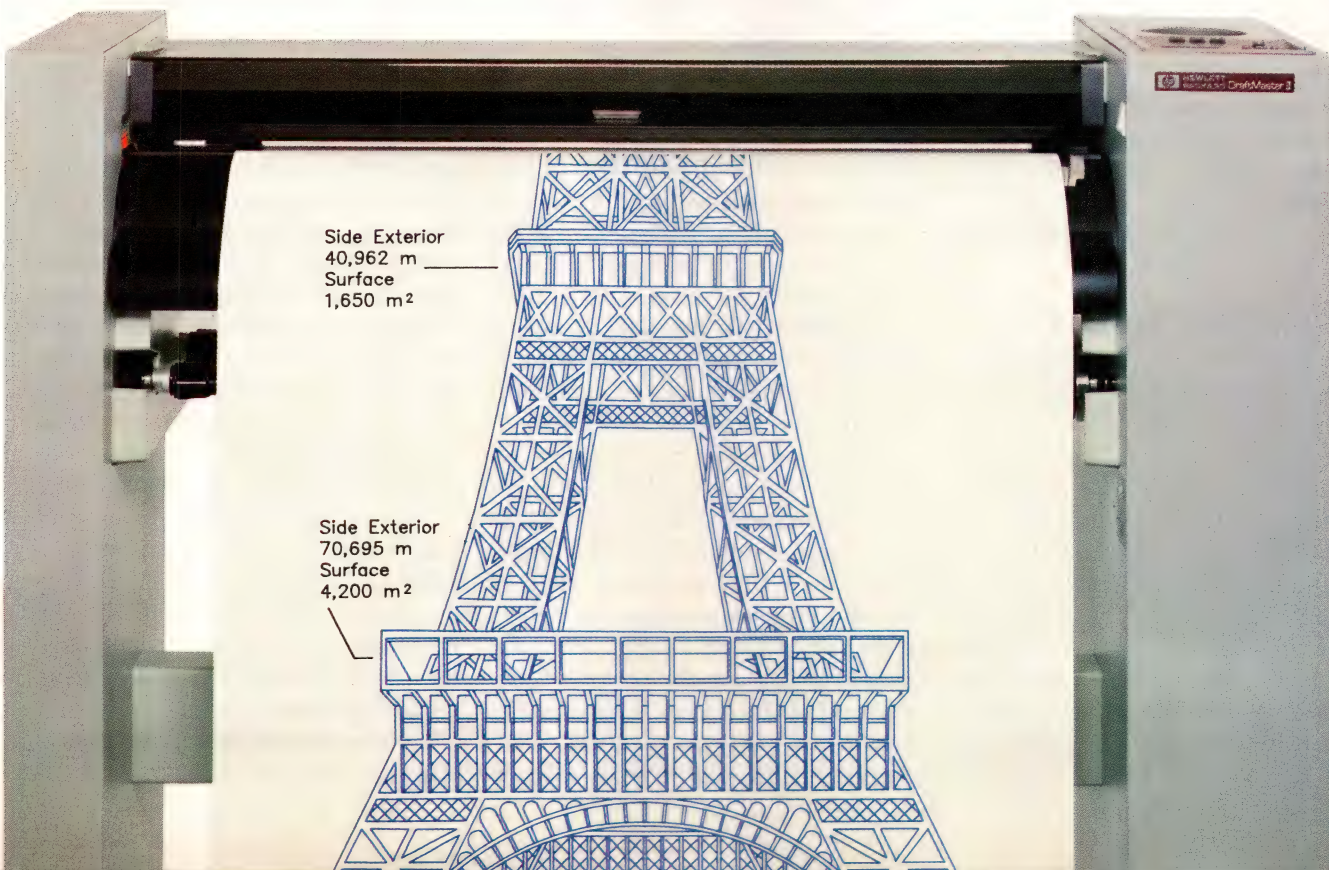
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Circle No 449

STD I/O CARD

The 500 I/O card combines four optoisolated inputs with four solid-state relays; it interfaces with the STD Bus for high-voltage ac switching and monitoring requirements. Each input channel converts signals in the 70 to 140V range to TTL signals for reading by the STD Bus input port. It provides a minimum of 1500V rms of optical isolation between inputs and the STD Bus. It has four independent triacs (solid-state relays) that are controlled by a latched 4-bit decoder that decodes output data from the STD Bus. When the decoder has enabled a triac, the triac switches on at the next zero-volt crossing of its ac input signal. When a triac has been disabled, it switches off at the next zero-volt crossing. The power switching is specified for ac loads as great as 280V. Each output provides a minimum of 1500V rms input/output isolation. An LED lets you monitor the status of each input and output. \$295.

Octagon Systems Corp, 6510 W 91st Ave, Westminster, CO 80030. Phone (303) 426-8540. TLX 4931919.

Circle No 450

DIGITIZING TABLET

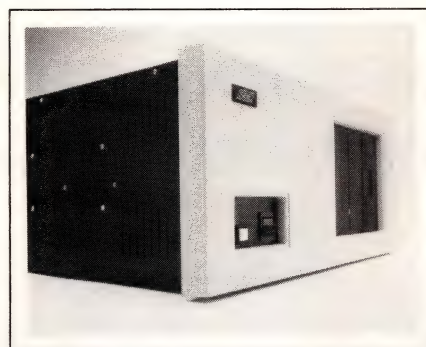
The 2205 low-cost digitizing tablet for personal computers offers 0.001-in. resolution over a 12×12-in. area. The vendor specifies the device's accuracy at ±0.02 in. Its output can be in one of four commonly used tablet formats. The tablet has a 9600-baud RS-232C interface; its output rate, which is selectable from the host, can be as high as 160 points/sec. Its standard features include firmware for self-diagnostics, host override of default conditions, and an audible tone. The 2205



weighs 5½ lbs and measures 16½×16½×¾ in. The total package includes a 12×12-in. tablet, a stylus or 4-button keypad, a power supply, and an RS-232C cable. \$650.

Numonics Corp, 101 Commerce Dr, Montgomeryville, PA 18936. Phone (215) 362-2766. TWX 510-661-6585.

Circle No 451



UNIX V COMPUTER

The Model 500/550 system single-board Multibus I computer runs Unix System V, release 2.0. Its 32-bit 68020 CPU runs at 12.5, 16.7, or 20 MHz. It has 1M bytes of 1-wait-state, dual-ported dynamic RAM. The board also has an MMU module that provides multiuser capabilities and offers an additional 1M byte of dynamic RAM. You can configure the system with a 1.2M-byte floppy-disk drive and a hard-disk drive that provides 20M to 280M bytes of storage. It comes with two RS-232C communication channels. The vendor provides software that lets you program the board in C, Fortran, assembly language, Snobol, and Probug. Option-

al X.25 software is also available. The 500 has nine available slots; the 550 has five. The Regulus operating system (from Alcyon Corp) is available for systems that don't require memory management. \$11,835 for a system configured for Unix System V; \$1300 for Unix System V software; \$750 for Regulus software.

SBE Inc, 2400 Bisso Lane, Concord, CA 94520. Phone (800) 221-6458; in CA, (800) 328-9900. TWX 910-366-2116.

Circle No 452



THERMAL RECORDER

The AR-41 2-in. thermal array recorder comes with demonstration software that allows you to connect the recorder to a personal computer and begin using it within 15 minutes. The demonstration software comes on a floppy disk and runs on IBM PCs and compatibles under MS-DOS 2.0 or higher. The recorder provides resolution to 200×800 dots/in. and can use 50-mm paginated/semiperforated or plain 50-mm roll paper. It uses curve-smoothing software to print graphics, text, bar codes, histograms, and waveforms.

As a printer, the AR-41 can print the 96 ASCII character set horizontally or vertically. It runs at user-programmable speeds of 20 mm/hour to 50 mm/sec and is controlled by a hybrid stepper-motor system. Optical sensors automatically shut the recorder off when it's out of paper. The recorder/printer is

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Max. Sweep Speed	500 psec	500 psec	500 psec	500 psec	1 nsec
Vertical Sensitivity	2 mV/div	2 mV/div	2 mV/div	2 mV/div	2 mV/div
Trigger Frequency	500 MHz	500 MHz	500 MHz	500 MHz	250 MHz
GPIB	Standard	Standard	Standard	Optional	Optional
Counter/Timer/Trigger/Word Recognizer	Standard	Standard	Standard	Optional	Optional
Digital Multimeter	Standard	Standard	Not Available	Optional	Optional
Video Trigger	Standard	Not Available	Not Available	Optional	Optional
Probes	4	4	4	2	2
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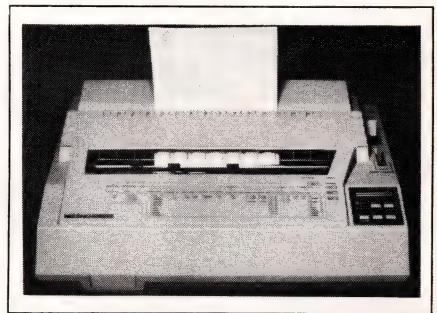
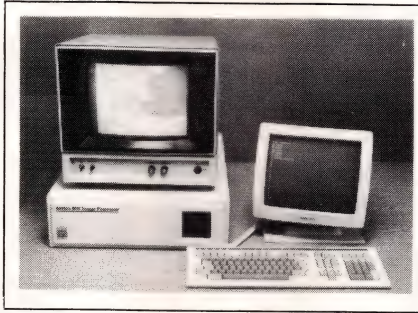
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Computers and Peripherals

housed in a lightweight, injection-molded, glass-filled polycarbonate chassis. \$420.

General Scanning Inc, Box 307, Watertown, MA 02272. Phone (617) 924-1010.

Circle No 453



rithmic flexibility, according to the vendor. The Series 200 is made up of four modules that are linked to a MicroVAX II computer via a Q Bus repeater. The modules are an A/D interface, a dual-scanning frame buffer, a 50-MOPS (million operations/sec) pipeline processor, and a high-speed (16-MIPS) array processor. The processor incorporates a programmable video-bus network that uses four bidirectional, 10-MHz frame buses to transfer data between modules.

The processor performs interpolated zooming and rotation of 512×512-pixel images in 1.05 and 0.44 sec, respectively. The vendor also supplies a library of image-processing routines that run under the MicroVMS operating system. The software is written in C and HSP-200 microcode. The Series 200 comes in a rack-mountable or table-top enclosure with an 8-slot chassis. \$28,995. Delivery, 60 to 90 days ARO.

Imaging Technology Inc, 600 W Cummings Park, Woburn, MA 01801. Phone (617) 938-8444. TLX 948263.

Circle No 454

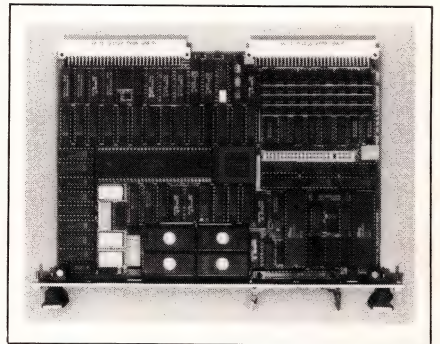
24-WIRE PRINTER

The NP-2405 24-wire dot-matrix printer is suitable for continuous-form, spreadsheet, and word-processing applications. You can use the LCD control panel to preset as many as three printing formats, so you can switch quickly from spreadsheets to letterhead to multipart forms. The unit can print draft-quality text as fast as 428 cps and letter-quality, 12-character/in. text

as fast as 96 cps. Optional, interchangeable modular interfaces for the printer include a Centronics interface, a Centronics interface with a 30k-byte buffer, and an RS-232C interface with a 30k-byte buffer. The NP-2405 also offers nine resident fonts, downloadable characters, superscripts and subscripts, IBM PC compatibility, and Epson LQ-1500 emulation. Optional plug-in font cartridges are available. The printer weighs 31 lbs and measures 23.6×15.4×8.3 in. \$1295.

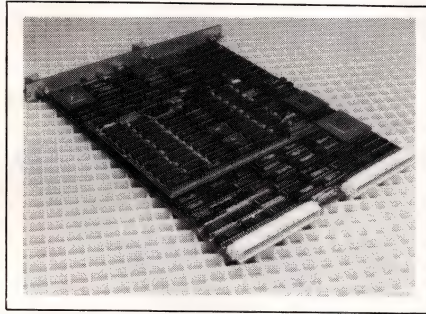
Nissho Information Systems, 10855 Business Center Dr, Suite 100, Cypress, CA 90630. Phone (800) 952-1919; in CA, (714) 952-8700. TLX 361150.

Circle No 456



VME BUS μ C

The HK68/VE microcomputer board for the VME Bus is designed for real-time applications and dedicated control tasks. It includes a 10- or 12.5-MHz 68000/68010 MPU; as many as 4M bytes of onboard, dual-access dynamic RAM; as many as 256k bytes of EPROM; two RS-232C serial ports (RS-422 ports are optional); a single 8/16-bit iSBX connector; mailbox support; and a full interface (including system-control-



ACCELERATOR BOARD

The Vortex family is a range of accelerator boards for the IBM PC/AT, Multibus II, and NuBus workstations. They can execute as many as 20 single-precision MIPS (in 32-bit mode) or as many as 10M double-precision flops (in 64-bit mode). The boards' architecture has an internal data bus whose 80M-byte/sec transfer rate provides quick memory access to the arithmetic units. The boards were developed for the Intel iPSC Series parallel-processing computers. By integrating a Vortex board on each CPU-board node of an iPSC-VX system, the vendor was able to configure 64 vector nodes to provide 424M flops. The board has an optional software package, called Vex, that converts standard Fortran 77 language programs to vectorized language programs. IBM PC/AT version, \$9900; Multibus II and NuBus versions, \$11,900. Delivery, 60 days ARO. Vex option, \$5000. Delivery, 90 days ARO.

Sky Computers Inc, Foot of John St, Lowell, MA 01852. Phone (617) 454-6200.

Circle No 455

IMAGE PROCESSOR

The Series 200 image processor yields high throughput and algo-

Our high performance VMEbus/SCSI adapter won't take a bite out of your wallet.



The Rimfire® 3500 SCSI Host Bus Adapter is for VMEbus users who want it all. Performance. Versatility. And low price.

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It's for those who want a simple command queuing software interface, free of timing restrictions. For those who want to conserve bus bandwidth with a 30 Mbyte/sec VMEbus burst rate.

And for those who want to overlap commands on peripheral devices, the adapter supports disconnect/reconnect.

The Rimfire 3500 adapter is for integrators who want floppy

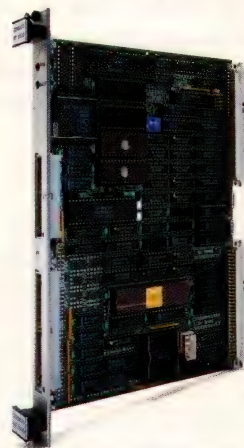
support for up to 4 dual or quad density drives.

For those looking ahead to faster data rates, the Rimfire 3500 adapter provides 4.0 Mbyte/sec synchronous as well as 1.5 Mbyte/sec asynchronous transfer rate capability. For interconnection flexibility, differential transceivers are an option.

Behind all this high performance is Ciprico support. A full staff to develop and support UNIX® drivers. Factory and field support engineers. 48-hour turnaround on board repair. And the expertise gained from over 40,000 disk and tape controller boards installed worldwide.

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The Rimfire 3500 adapter is the best price/performance VMEbus/SCSI adapter you can get. OEM pricing is under \$995.



The Ciprico Rimfire 3500 Host Bus Adapter enables VMEbus system developers to take full advantage of any high performance SCSI device. Software support for the board includes drivers for the System V and BSD 4.2 versions of the UNIX operating system.

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Ciprico Inc.

2955 Xenium Lane
Plymouth, MN 55441
612-559-2034

For more information call from your modem **1-800-332-0012** (300-1200 baud, 8 bit, no parity 1 stop bit) and enter the access code **CIPBUS2** when prompted. (In VA call 703-476-5255)

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Computers and Peripherals

ler functions) to the VME Bus. It also provides four user-programmable LEDs.

Options for the board include a 2-channel 68440 or 4-channel 68450 DMA chip for memory-to-memory or device-to-memory transfer, a 68881 floating-point processor module, an ANSI-compatible SCSI interface module, and a time-of-day clock with battery backup. The board requires 5V dc at 8.0A, 12V dc at 0.6A, and -12V dc at 0.2A. \$895 (100).

Heurikon Corp, 3201 Latham Dr, Madison, WI 53713. Phone (608) 271-8700. TLX 469532.

Circle No 457



SMALL COMPUTER

The Acer 710 IBM PC/XT- and PC/AT-compatible computer measures 5×14.2×16.2 in. Its 16-bit 8088 CPU runs at 4.77 or 10 MHz (you can switch the clock speed via software or the keyboard). Its graphics-display capabilities include IBM CGA, Hercules, MDA, and Plantronics Colorplus functions. It has 256k bytes of RAM that's expandable to 768k bytes, four system-expansion slots, and 16k bytes of ROM that's expandable to 64k bytes. It contains two 360k-byte, 5¼-in. floppy-disk drives. Optionally, you can configure the system with a 360k-byte, 5¼-in. floppy-disk drive and a 20M-byte, 5¼-in., half-height hard-disk drive. It also has a

real-time clock/calendar with a backup battery, and it provides one RS-232C interface and one parallel printer port. It runs MS-DOS 3.2.

Multitech Electronics Inc, 401 Charcot Ave, San Jose, CA 95131. Phone (408) 922-0333.

Circle No 459

Multitech European Liaison Office, Liesegangstrasse 9, 4000

Dusseldorf 1, West Germany. Phone (0211) 353941. TLX 8584103.

Circle No 460

TAPE CONTROLLER

The Tapemaster 2000 is a ½-in.-tape controller for Multibus II systems. It controls as many as eight formatted start/stop or streaming, GCR,

With OS9
Sys 11

- SYS 10 Features
- CPU06
- 512 Kbyte DRAM
- SCSI Interface
- OS9 Operating System

With UNIX
UNIX 03

- Single User License
- 68010 @ 10 MHz
- 1 Mbyte DRAM
- MMU 68451
- SCSI & OMTI 5400
- 1.6 Mbyte Floppy
- 51 Mbyte Winchester
- 53 Mbyte Streamer Tape

UNIX 04

- Multi-User License
- Features Same as UNIX 03

Chassis Only
Sys 09

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Sys 10

- One 1.6 Mbyte Floppy Drive
- One 25 Mbyte Winchester
- One OMTI 5400

(CPU, Interface and Software must be ordered separately)

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- 200 Watt Power Supply
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- PDOS — Trademark of Eyring
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- UNIX by UNIPUS — TM of Unisoft
- UNIX — Trademark of AT&T Bell Labs

European Headquarters

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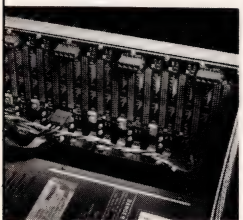
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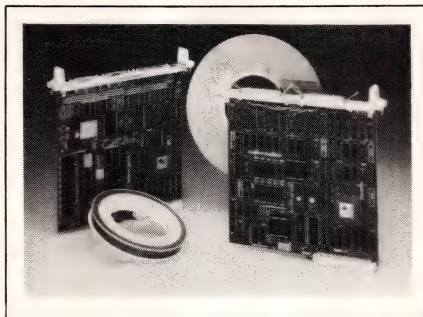
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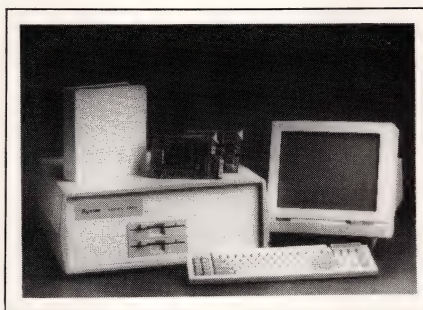
Computers and Peripherals



PE, or NRZI Pertec-compatible ½-in.-tape drives. It can handle data rates to 1.5M bytes/sec, and it allows you to write or read records of as much as 512k bytes. It bursts solicited data transfers across the Multibus II at 32M bytes/sec. Operations between the Multibus II system and the controller's 512k-byte data buffer can have a sustained throughput rate of 6M bytes/sec. The controller card's internal command queue has a capacity of about 150 commands. The double-height Eurocard board occupies a single card slot. The vendor offers drivers for the iRMX 286 and Unix V operating systems. \$2495.

**Ciprico Inc, 2955 Xenium Lane,
Plymouth, MN 55441. Phone (612)
559-2034.**

Circle No 458



PC-DOS FOR STD

The 7001 PC-DOS Development System provides a PC-DOS engine for the STD Bus. You can use it as a development tool or as a production board set. It consists of two boards: the 8810 CPU board and the 6440 Universal Memory board. The system has 128k bytes of battery-backed RAM and a 256k-byte EPROM disk. The 8810 board has one RS-232C port, an interrupt con-

troller, a real-time clock, and a parallel port. The EPROM disk is pre-programmed with PC DOS and some utilities; it also has room for user-programmed software.

You develop software on a host IBM PC/XT, PC/AT, or compatible machine and transfer it to the 7001 over an RS-232C link or by programming an EPROM. Because the BIOS for the 7001 closely matches the IBM BIOS, most IBM PC software can run on the 7001. You can accommodate mass-storage devices by adding a SCSI SBX module to the 8810 board. \$995.

**Systek, 1027 N Kellogg St,
Kennewick, WA 99336. Phone (509)
735-1200.**

Circle No 461



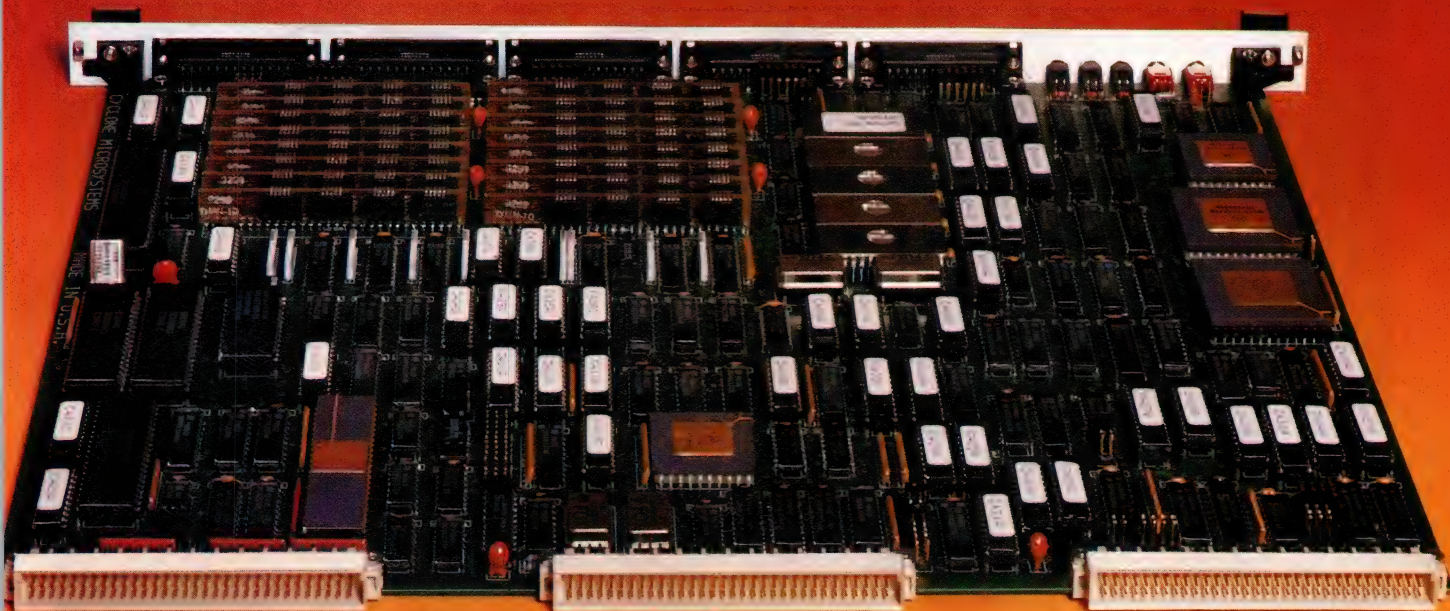
CLUSTER CONTROLLER

The CIE 4071 cluster controller interfaces four to eight IBM 3270-compatible terminals, printers, and ASCII devices. An ASCII printer connected to an RS-232C port on the CIE-4071 will appear to the host as an IBM 3287 printer, so you can use the printer with IBM 3287 software. You don't need a coax port for local printing. The cluster controller communicates with the host via an RS-232C interface at speeds to 19.2k bps and handles SNA/SDLC or BSC communication modes. Based on the 80186 µP, the CIE-4071 features 1M byte of memory and a 3½-in. floppy-disk drive. The controller comes with remote diagnostics. It weighs 18 lbs and measures 17.63×12.63×3.75 in. \$3995.

**CIE Systems Inc, 2515 McCabe
Way, Irvine, CA 92714. Phone (714)
660-1800.**

Circle No 462

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CY4110

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| <input type="checkbox"/> MC68881 Floating Point CoProcessor (Optional) | <input type="checkbox"/> SCSI Controller-1.5 Mbytes/sec. |
| <input type="checkbox"/> MC68851 Paged Memory Management Unit (Optional) | <input type="checkbox"/> Parallel Printer Port |
| <input type="checkbox"/> 2 or 4 Mbytes DRAM with parity | <input type="checkbox"/> 4 RS-232-C Ports |
| <input type="checkbox"/> 5 JEDEC Sockets | <input type="checkbox"/> 24 Bit Counter/Timer |
| <input type="checkbox"/> MC68440 2 Channel DMA Controller | <input type="checkbox"/> Real Time Clock |
| | <input type="checkbox"/> VMEbus Master/Slave Interface (A32,D32) |

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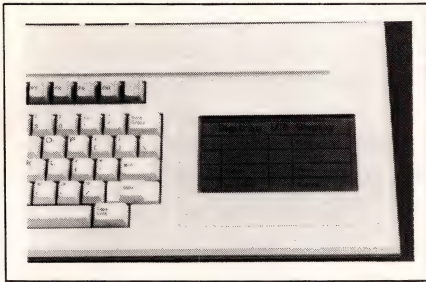
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Computers and Peripherals

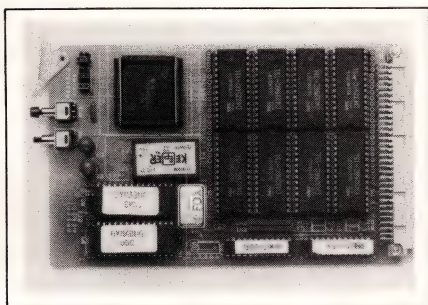


KEYBOARD

The LCD Touch-Screen Keyboard combines an LCD touch panel with a main keyboard. The touch panel measures 5×2¾ in. You can use it as a cursor controller, a programmable keypad, or both. The keyboard is available in IBM PC/XT and PC/AT, ASCII, or custom formats. Using the keypad, you can incorporate macrokey words, short and long strings, or icons in programmed screen options. The bundled software allows you to develop screen formats directly from the keyboard, to increase the number of function keys without retooling, and to save menus or icons on multiple screens. A list of commands for custom menus is provided with the software. \$395.

Xcel Corp, 3100 New York Dr, Pasadena, CA 91107. Phone (818) 791-5600.

Circle No 463



LOW-COST SBC

The RM65-68000 is a single-board computer on a single-height Eurocard. The all-CMOS product is based on a 68HC000 or 68HC010 CPU that operates at 8, 10, or 12.5 MHz. It has as many as 16 sockets (eight on the board, eight on a piggyback module) for static RAM, each accepting 32k-byte chips, for a

total of 512k bytes of battery-backed RAM. It also has two 32-pin JEDEC sockets that accept 27C128 to 27C1024 EPROMs, for a total of 256k bytes. The onboard ACIA serial interface has a software-controllable baud rate. You can prepare programs on an IBM PC or compatible computer and download them to the module; the vendor supplies a C

cross-compiler and a macroassembler, both of which run on the PC. The company also supplies debugging software. RM-68000, with 8-MHz CPU and 64k bytes of RAM, \$420.

Dynatem Inc, 19 Thomas, Irvine, CA 92718. Phone (714) 855-3235.

Circle No 465

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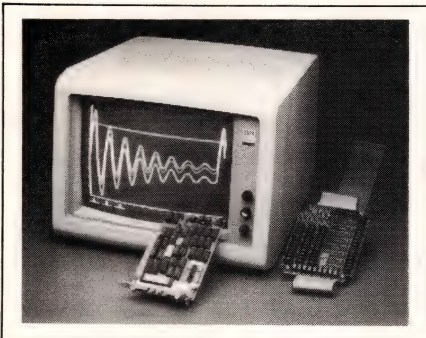
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CIRCLE NO 28

Computers and Peripherals



DATA-ACQUISITION CARD

The Analog Connection Jr is a data-acquisition card for the IBM PC, PC/XT, PC/AT, and compatibles. It has eight differential analog inputs with 12-bit resolution to $\frac{1}{10}$ of full scale over six software-selectable ranges: ± 25 mV, -5 to $+50$ mV, ± 250 mV, -50 to $+500$ mV, ± 5 V, and -1 to $+10$ V. It samples at 10,000 samples/sec with a low-noise ($2\text{-}\mu\text{V}$ noise), integrating converter over all ranges. Its factory calibration is guaranteed for 2 years.

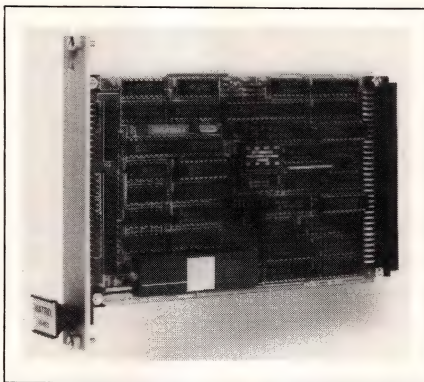
The card also provides cold-junction compensation and linearization for 10 thermocouple types: E, J, K, T, B, R, S, C, D, and G. The vendor provides application software (in Basic) for data acquisition, data logging, real-time graphing, control, and alarms. Driver software, which also comes with the card, is available in six languages: interpreted Basic, compiled Basic, Pascal, C, assembly language, and Asyst. \$595.

Strawberry Tree Computers,
1010 W Fremont Ave, Sunnyvale,
CA 94087. Phone (408) 736-3083.

Circle No 464

DISK CONTROLLER

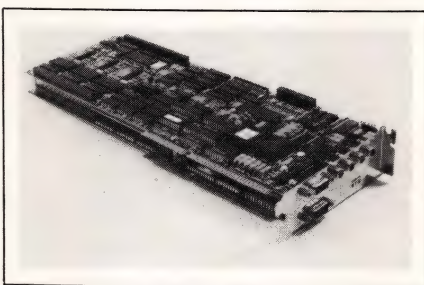
The MS-HFD is a hard- and floppy-disk controller on a single-height VME Bus card. It incorporates a 68454 Intelligent Multiple Disk Controller (IMDC) for controlling as many as four disk drives. The board can act as an A16/D16 slave occupying 256 bytes that can be located anywhere within the 64k-byte addressing range. It can also act as an A24/D16 master during DMA trans-



fers between disk and memory. The board can control two ST506 Winchester drives at a data rate of 5M bps. It can control floppy-disk drives at data rates of 125k, 250k, and 500k bps. It provides write pre-compensation for both floppy-disk and Winchester drives. \$849.

Matrix Corp, 1203 New Hope Rd,
Raleigh, NC 27610. Phone (919)
833-2000.

Circle No 466



IMAGING BOARD

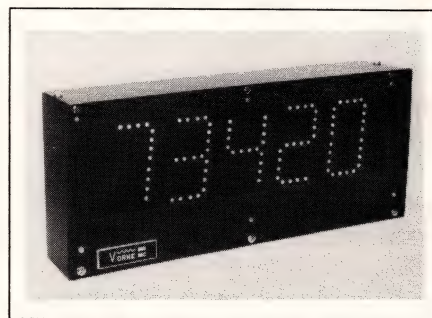
The MVP-AT 2-board set for the IBM PC/AT combines true-color frame grabbing and medium-resolution graphics with a range of real-time image-processing techniques. It can digitize a broad range of signals, including RS-170 monochrome or NTSC color inputs, in real time. It can display as many as 16.7 million colors simultaneously; it also offers 256 gray-scale levels. It contains 1M byte of onboard memory, which is organized as four $512 \times 512 \times 8$ -bit buffers. It also contains a Hitachi ACRTC graphics controller, which provides the capability to overlay a processed image with text, graphics, and cursors.

The onboard ALU can perform real-time, single-image operations

(such as frame averaging and convolutions) as well as inter-image operations (such as addition and subtraction) at a rate of 12 million pixels/sec. The vendor provides application software written in Microsoft C. The board set also runs Dr Halo II and Image Pro from Media Cybernetics. \$4995.

Matrox Electronic Systems Ltd,
1055 St Regis Blvd, Dorval, Quebec, Canada H9P 2T4. Phone (800)
361-4903 or (514) 685-2630.

Circle No 467



DIGITAL DISPLAY

The Model 77/232 2- to 6-digit display has 3-in.-high characters and accepts serial data input. Communication with the display takes place via a 2-wire bus in TTL, current-loop, RS-232C, RS-422, or RS-485 format at 300, 1200, 2400, 4800, or 9600 baud. You can address as many as 98 displays individually on the 2-wire bus via internal DIP switches. Each display has a plug-in communications board that determines the type of serial data transfer. It can display 11 characters (the numbers 0 through 9 and a blank space), which are loaded in ASCII format. A reset line places the display in power-up state, in which it shows all zeros. The display requires 120V ac at 15 VA. \$325 (two digits) to \$425 (six digits).

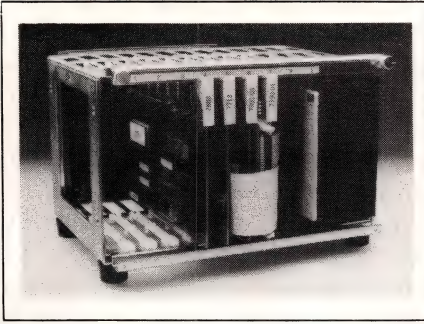
Vorne Industries Inc, 5831
Northwest Hwy, Chicago, IL
60631. Phone (312) 775-9440.

Circle No 468

STD BUS COMPUTER

The System 2 computer for the STD

Computers and Peripherals



Bus is fully compatible (at the chip level) with IBM PC/XT DOS and BIOS software. It runs MS-DOS 3.2. You can expand and customize the system by adding STD Bus cards. The system is based on a 5-MHz NEC V20 microprocessor. It has 128k bytes of CMOS RAM (expandable to 640k bytes) and comes in two versions.

The Model 10, which has two semiconductor disk drives, is designed for systems that will be exposed to excessive temperature, vibration, or moisture. A 20M-byte hard-disk drive is optional. The Model 20 has a 3½-in. floppy-disk drive; a second floppy-disk drive and a 3½-in., 20M-byte hard-disk drive are optional. Both models contain a serial port, a time-of-day clock, and seven to 23 expansion slots. Model 10, \$1195; Model 20, \$1595.

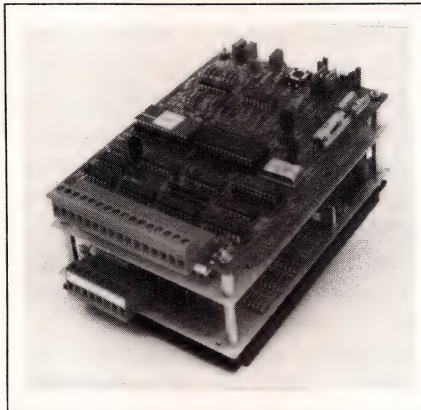
Pro-Log Corp, 2560 Garden Rd, Monterey, CA 93940. Phone (800) 538-9570; in CA, (408) 372-4593. TWX 910-360-7082.

Circle No 530

sor system, each processor has priority access to its own memory through its local VSB bus. Interprocessor communication and I/O transfers take place over the VME Bus. The VME Bus access time is 230 nsec for reads and 180 nsec for writes. The VSB access time is 220 nsec for reads and 200 nsec for writes. The board uses 1M-byte dynamic-RAM chips with internal refresh and has 32-bit data paths; starting addresses are selectable on any 16M-byte boundary. The board performs 32-, 16-, and 8-bit data transfers, so you can use it with any combination of processors and DMA devices on the VME Bus. It uses byte-wide parity checking on all reads to preserve data integrity. \$8995.

Dual Systems Corp, 2530 San Pablo Ave, Berkeley, CA 94702. Phone (415) 549-3854.

Circle No 469



MOTOR CONTROLLER

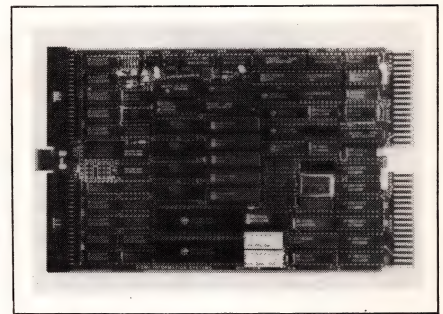
The PIC-850 Series motor controller can control both the position and the velocity of a dc motor with incremental encoder feedback. Packaged with a pulse-width-modulated dc-motor driver, the controller can replace a stepper-motor system with a servo system. It accomplishes motor control by comparing an input pulse stream with the feedback from an incremental encoder. It uses a separate direction line to control the motor's direction. It can control dc motors of as much as 3 hp at resonant-free speeds from 0 to 600,000

pulses/sec.

The controller can handle position errors to 32,767 counts, and it has an onboard, 13-bit D/A converter that provides an analog error signal in the $\pm 10V$ range. The controller is available with a pulse-width-modulated amplifier of as much as 5 kW. Because the controller/amplifier is in a single package, the system requires only one dc voltage. For 10A/70V motors, the PIC-850 costs \$995; for 10A/150V motors, it costs \$1250; and for 16A/150V motors, it's \$1550.

Galil Motion Control, 1928-A Old Middlefield Way, Mountain View, CA 94043. Phone (415) 964-6494. TLX 171409.

Circle No 531

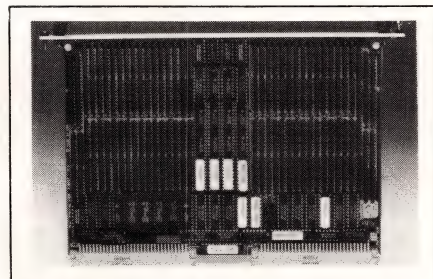


8-LINE MULTIPLEXER

The SCD-DHV11/8 8-line serial, asynchronous communication multiplexer for the DEC Q bus is designed for multiuser systems that require modem control or character buffering. You can control a modem via each of the multiplexer's eight lines, which are compatible with EIA RS-232C and RS-423A interfaces. The module includes a 256-byte character buffer for received characters and DMA for transmitted data. Each channel's baud rate is independently controlled and can reach 38.4k baud. Two 40-conductor cables connect to the module and distribute signals to DB25 connectors. The board is fully compatible with DEC operating systems. \$792.

Sigma Information Systems, 3401 E La Palma Ave, Anaheim, CA 92806. Phone (714) 630-6553. TLX 298607.

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MEMORY BOARD

The VMEM-16MB is a VME Bus memory board that provides 16M bytes of dual-ported memory on one card and accepts both VME and VSB Bus interfaces. When you use the memory board in a multiprocessor

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Computers and Peripherals



INTERNETWORK BRIDGE

The IB/1-FT is an internetwork bridge that provides fault-tolerant communication and increases traffic capacity across multiple similar or dissimilar LANs. The unit interfaces to two Ethernet (IEEE-802.3) LANs, two of the vendor's broadband LANs, or one of each. You can use any mixture of cable media, including 10M-bps Ethernet baseband coaxial cable, 5M-bps broadband coaxial cable, and 10M-bps fiber-optic cable. The unit's redundant data-link system automatically switches operation to the alternate data link when a component fails. The IB/1-FT can double the throughput between subnets by using the full 10M-bps bandwidth available through the redundant system. Its redundant Ethernet system can take advantage of the full 20M-bps bandwidth. \$12,000 with data links, plus \$350 for a software license.

Bridge Communications Inc., 2081 Stierlin Rd, Mountain View, CA 94043. Phone (415) 969-4400. TLX 176544.

Circle No 533

MODEM

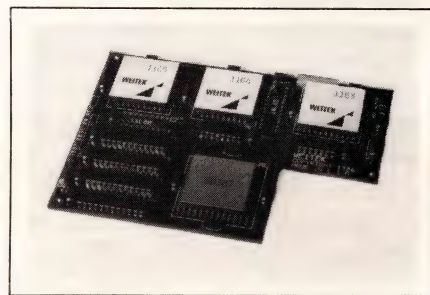
The AJ 2412-STH low-cost modem is fully compatible with the 2400-bps Hayes AT command set. It includes nonvolatile EEPROM storage for 10 telephone numbers. It meets CCITT V.22 bis and V.22 protocols and Bell 103 and 212A standards. It operates asynchronously or synchronously at data rates between 300 and 2400 bps. You accomplish dialing by specifying the

memory location of a stored number in an AT command. You can also initiate dialing from a front-panel switch.

When originating a call, the modem can detect a busy signal, ringback, or voice, and then send the appropriate message to the terminal. In answer mode, the modem automatically detects the speed of the originating modem and sets itself accordingly. It allows access only to external modems that have a correct answer-back code. MNP error correction is optional. \$395; \$545 with MNP option.

Anderson Jacobson, 521 Charcot Ave, San Jose, CA 95131. Phone (800) 423-6035; in CA, (408) 435-8520. TWX 910-338-0136.

Circle No 534



MATH COPROCESSOR

The 1167 is a floating-point math coprocessor for the Intel 80386 microprocessor. This daughter board that plugs into the 121-pin Extended Math Coprocessor socket on an 80386-based mother board. The board contains floating-point math chips and a proprietary interface controller. According to the vendor, it offers higher-performance math processing than that afforded by an 80387 math coprocessor. Software support for the 1167 includes high-level C, Fortran, and Pascal compilers from Green Hills Software, Language Processors Inc, and Silicon Valley Software. The 1167 runs under Unix V/386. \$950.

Weitek Corp, 1060 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 738-8400.

Circle No 535

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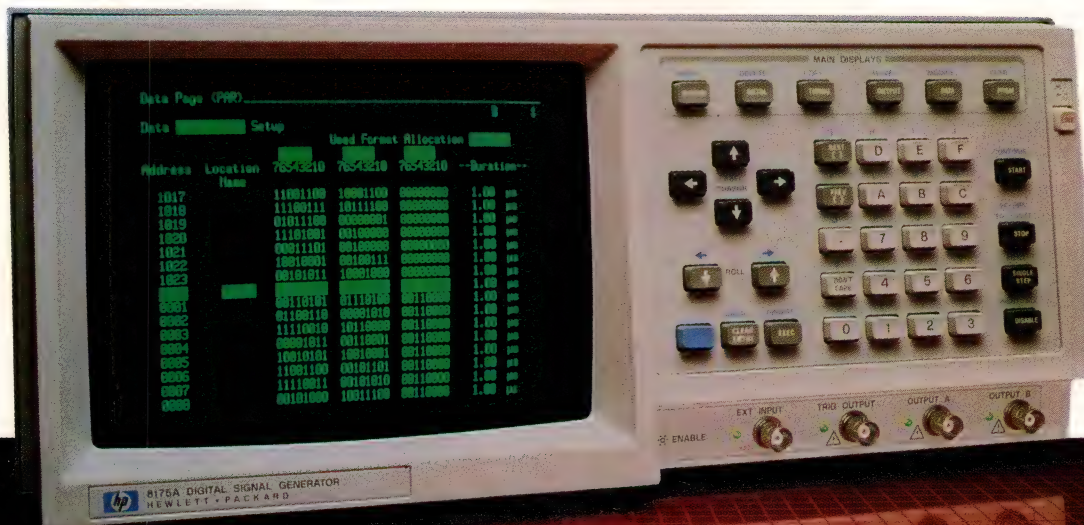
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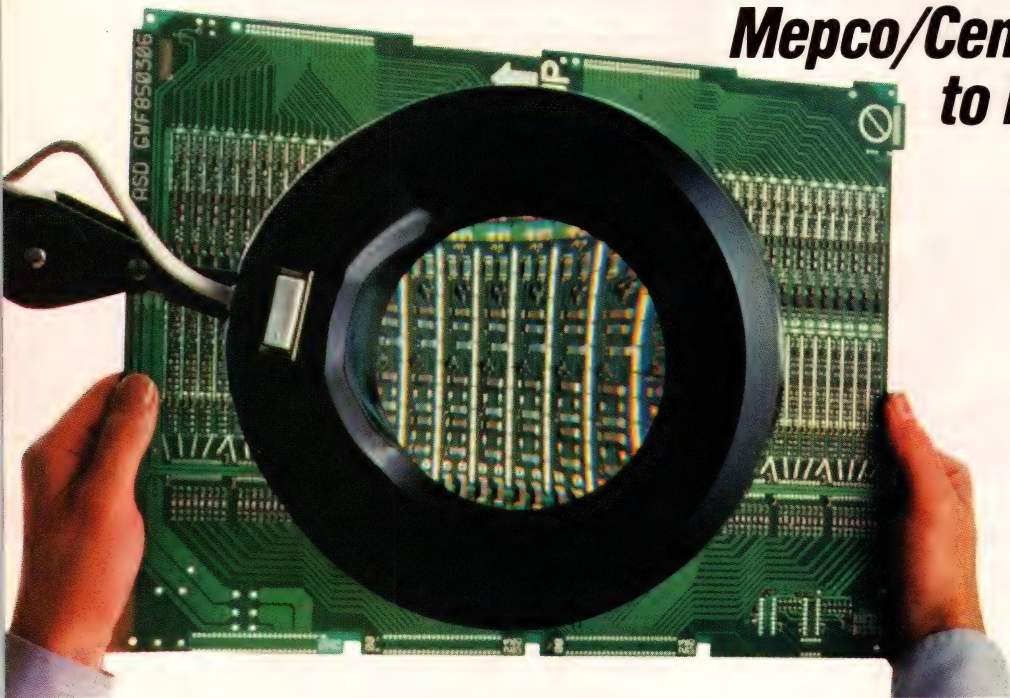
Disk Products Division, 9740 Irvine Boulevard, Irvine, CA 92718

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CIRCLE NO 163

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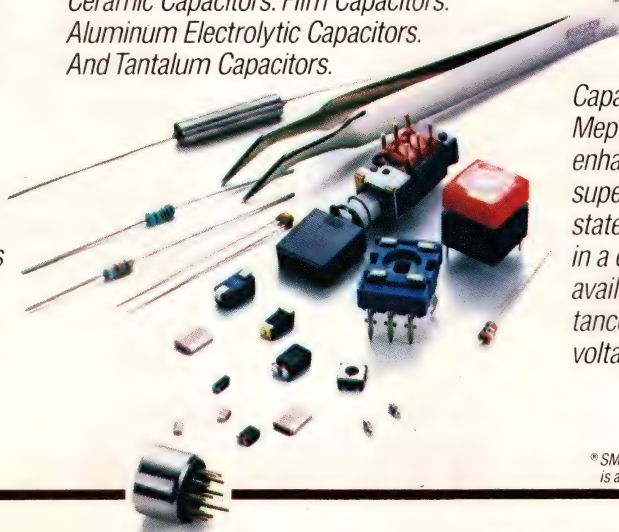
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FCC regulations encourage you to shield EMI selectively

The FCC has cracked down hard on home computers and peripherals—the prevalent source of electromagnetic interference. Yet EMI products and services can help you comply with these regulations. And by considering EMI at the planning stages, you can cut the overall shielding costs too.

Tarlton Fleming, *Associate Editor*



*Conductive gaskets, O-rings, and extruded elastomers
(Chomerics)*

Electromagnetic interference (EMI), always a problem in radio communications, is now a serious concern for all manufacturers of computers and related equipment—including electronic games, pocket calculators, and digital watches. The Federal Communications Commission has developed a very effective strategy for monitoring compliance. Products are available, however, that let you test and shield your designs selectively, so that, by considering EMI early on in your design planning, you can avoid costs—as well as headaches—later on.

In response to a deluge of complaints about EMI, the FCC created a Sampling and Measurement Branch in 1984, followed by a more general reorganization in 1986 that produced greater vigilance and more aggressive action by district offices of the commission's Field Operations Bureau. (See **box**, "Know the rules: Who regulates EMI?") The result has been a striking increase in the rate of prosecution regarding issues of EMI-related product liability. In the first six months alone of 1986, the FCC issued \$250,000 worth of fines, ten times the value of all the fines issued in 1985.

Most of the interference cases that precipitated an FCC crackdown followed a surge in the ownership of home computers and related digital products. Design-



Conductive materials for EMI-shielding applications (Tecknit)

You can't just put your product in a metal box and be done with it.

ing these products to meet the EMI regulations has become more difficult, partly because the products pack more digital circuitry into VLSI chips. And today's VLSI chips impose their own penalties: Their lower supply voltages reduce the internal noise margins; their finer geometry invites arc-over damage at lower levels of static electricity; and their faster, synchronous operation generates sharper current pulses that in turn escalate the problem of broadband emissions from the I/O cables.

Underplanning leads to overshielding

What's more, you can't just put your product in a metal box and be done with it. The federal control of EMI calls for a more sophisticated approach than the methods that prevailed a few years ago. The regulations really encourage you to consider EMI from the

beginning. Careful pc-board layout; the use of a ground plane; the use of component-level, pc-mounted shielding; and the use of power-entry modules that include an EMI filter—all these steps reduce the need for overall shielding. They also can help manufacturers save money by including only enough shielding to meet minimum requirements of the applicable regulations.

To achieve a cost-effective design, you need to use a variety of approaches in conjunction with the FCC regulations. An understanding of basic theory helps (see **box**, "Fundamentals of fields and waves"), but in practice you also need to use trial-and-error techniques for the many systems whose geometry is too complex to allow useful mathematical analysis. Furthermore, EMI suppression often involves as much mechanical as electrical engineering.

Mechanical expertise is one métier of a small group of

Know the rules: Who regulates EMI?

If you design electronic equipment for sale in the US, you must comply with the FCC regulations for radiated and conducted emissions. In addition, your company may require that the product operate in the presence of controlled levels of external EMI. Your responsibility therefore may be twofold—to assure the government your company's product won't bother anyone, and to assure the company that your design will perform satisfactorily for the customer.

If you plan to export products, you'll be wise to review the applicable foreign standards early in the design cycle. Some European countries, for example, specify the requirements listed by the VDE (Verband Deutscher Elektrotechniker, West Germany's equivalent of the IEEE), although at present these requirements are mandatory only in West Germany. Great Britain and Canada also have their own regulations.

One source for documents covering US and international standards and regulations is Compliance Engineering (Borborough, MA). The documents are in English and are divided into categories of EMI, safety, telecommunications, and ESD (electrostatic discharge).

In the US, FCC regulations affecting digital hardware went into effect in 1979. Part 15 of these regulations sets forth the requirements, which apply to all digital equipment that generates pulses at rates in excess of 10,000 pulses/sec. Although a single sharply defined pulse contains a broad spectrum of harmonic-frequency components, these harmonics have little energy unless reinforced by repetition. The FCC deems a repetition rate of 10,000 pulses/sec as the minimum threshold for nuisance emissions. The commission regulates these emissions between 10 kHz to 3 GHz.

FCC regulations divide digital

equipment into two classes:

Class A concerns products marketed for use in commercial, industrial, or business applications but excludes devices marketed for the general public. Class B products are meant for use in a residential environment, even if they also could be used in the class A environments. More stringent EMI limits apply to class B than to class A equipment (see **Tables A and B**).

Although a preponderance of FCC actions involves enforcement under Part 15 of the EMI regulation, which covers digital-computing devices, Part 18 is relevant too. The regulations in the latter part have jurisdiction over RF-generating systems intended for certain industrial, scientific, and medical (ISM) applications. These regulations specify maximum allowed emissions at the various spot frequencies and frequency bands from 10 kHz to 245 GHz, allocated for use by ISM equipment.

companies within the EMI-products industry that specialize in magnetic shielding. The group includes Advance Magnetics, Ammuneal Manufacturing, Eagle Magnetics, and the Magnetic Shield Division of Perfection Mica Company. These companies manufacture products that solve lower frequency, H-field problems (namely, those problems at 100 kHz and below). Magnetic-field sources, like motors and transformers, tend to operate at lower frequencies, and the nickel alloy materials commonly used to shield those sources lose their magnetic-shielding effect at higher frequencies.

Generally, EMI is difficult to contain unless you surround your noisy electronic system with a seamless, welded enclosure. But that kind of an enclosure is seldom practical. On the other hand, the seams in a practical enclosure warrant careful mechanical design to avoid degrading the enclosure's shielding effect.

What happens when a plane wave encounters a sheet-metal barrier illustrates one way that seams and apertures cause trouble. The wave's E field induces a nearly equal and opposite field in the metal surface, resulting in a near-zero voltage across the surface as you'd expect. The induced field drives a sheet of current on the surface. This current and the E-field strength decrease exponentially with depth into the metal, depending on the metal's conductivity and permeability. Current flow on the far side is then the cause of any field that passes through the metal barrier.

Uniform conductivity blocks EMI

An interruption in the metal surface that lowers conductivity (such as a metal gasket between two metal sheets) reduces the shield's effectiveness by forcing more current to flow on the far side. The extreme

If you sell electronic systems to the military market, you must be familiar with MIL-STD-461C (the C revision appeared this year), which imposes limits on a system's conducted and radiated susceptibility to EMI, as well as its conducted and radiated emissions. The companion document MIL-STD-462 specifies the necessary test setups. Also, commercial companies often incorpo-

rate portions of MIL-STD-461C in the self-imposed specifications for their own products.

Another military entity governing EMI emissions is the classified Tempest program, created to guarantee secure communications. Military products such as CRT terminals that are vulnerable to electronic eavesdropping techniques come under the jurisdiction of Tempest. If

you are considering designing such a product, companies like Atlantic Research Corp, Chomerics Inc, Dash Strauss & Goodhue Inc, and Norand Corp can help by performing the appropriate tests, proposing or executing redesigns to cure deficiencies, and generating the required supporting documents.

**TABLE A—FCC REQUIREMENTS
FOR EMI (PART 15, SUBPART J)
—CLASS A (INDUSTRIAL)
EQUIPMENT**

RADIATION LIMITS:		
FREQUENCY (MHz)	DISTANCE (m)	FIELD STRENGTH ($\mu\text{V/m}$)
30-88	30	30
88-216	30	50
216-1000	30	70

NOTE: CLASS A MEASUREMENTS CAN BE MADE AT ANY DISTANCE BETWEEN 3 AND 30m. IF THE TEST RESULTS ARE SCALED INVERSELY WITH THE DISTANCE, FOR EXAMPLE, AT 3m THE ALLOWABLE FIELD STRENGTH IN THE FREQUENCY RANGE 30 TO 88 MHz IS 300 $\mu\text{V/m}$.

CONDUCTED (POWER LINE) LIMITS:	
FREQUENCY (MHz)	MAXIMUM VOLTAGE (μV)
0.45-1.6	1000
1.6-30	3000

**TABLE B — FCC REQUIREMENTS
FOR EMI (PART 15, SUBPART J)
—CLASS B (MASS-MARKET)
EQUIPMENT**

RADIATION LIMITS:		
FREQUENCY (MHz)	DISTANCE (m)	FIELD STRENGTH ($\mu\text{V/m}$)
30-88	3	100
88-216	3	150
216-1000	3	200

CONDUCTED LIMITS:
FROM 0.45 TO 30 MHz, THE MAXIMUM VOLTAGE FED BACK TO THE LINE AT ANY FREQUENCY MUST BE LESS THAN 250 μV .

(SOURCE: COMPLIANCE ENGINEERING)

Generally EMI is difficult to contain unless you surround your noisy electronic system with a seamless, welded enclosure.

example of interruption is an actual hole, which transmits energy through the shield by means of the slot-antenna effect. But most methods of joining two pieces of metal (short of welding) compromise the metal's shielding effect somewhat.

Joining two metal sheets with a row of rivets through the overlapping portions, for instance, doesn't guarantee uniform contact between the sheets, regardless of the interval between rivets. Any gap in contact will transmit energy through the shield by acting like a slot antenna. Corrosion, too, can interfere with electrical contact between the metal surfaces in some cases. Copper oxide, for example, is conductive, but aluminum oxide is not.

Providing uniform electrical conductivity across metal seams complicates the construction of most EMI enclosures. In some cases, aligning the seam with the incident radiation's E-field vector reduces the problem. Most cases, though, call for the use of specialized products such as wire mesh and conductive-elastomer gaskets for doors and covers; conductive O-rings and flat washers for wave-guides; shielded windows, air vents, connectors, and cables; and conductive-thermoplastic materials.

Conductive thermoplastics are attracting renewed attention for use in EMI shielding and ESD (electrostatic discharge) control. Wilson-Fiberfil is one source of these products. By embedding aluminum flake, stainless-steel fibers, or electrically conductive carbon black in a binder of thermoplastic, the company produces strong, stiff, conductive materials suitable for use as instrument enclosures and tool housings. These materials can sometimes offer an alternative to metal enclosures and to enclosures made of conventional plastic covered with conductive coatings or zinc spray.

Chomerics offers a wide array of EMI-shielding products. Its conductive elastomers, for example, consist of a silicone or fluorosilicone combined with particles of silver, silver-plated copper, silver-plated aluminum, or silver-plated glass. The result is a resilient, rubbery, conductive material that is useful as a gasket for ensuring electrical contact between metal surfaces. In the form of extruded strips, for example, these materials come in a variety of cross sections, wound on large spools. A typical 500-ft length of 1/8-in.-diameter strip costs \$1.50 to \$3.50/ft, depending on the composition.

Chomerics also sells wire-mesh gaskets with a non-conductive rubber core that maintain electrical conductivity between an enclosure and its hinged or removable

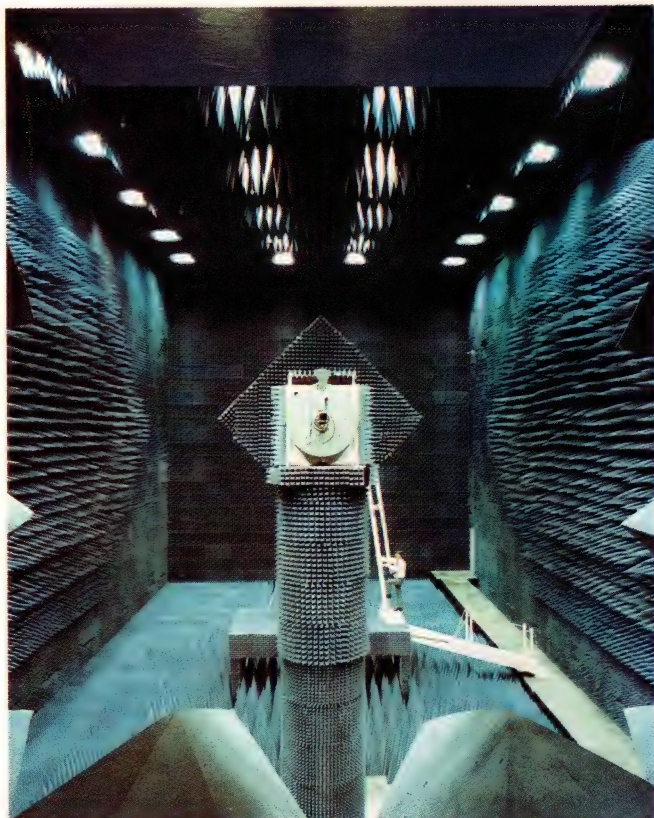


Fig 1—Simulating the EMI conditions of deep space, this 50×50×100-ft, RF-anechoic chamber is suitable for testing satellites. Ray Proof built the chamber for Marconi Space Systems.

cover. Available in spools, this type of gasket costs about \$0.50/ft (500 ft).

Viewing windows block EMI

Tecknit and Tech-Etch offer wire-mesh and conductive-elastomer materials similar to those from Chomerics. In addition, Tecknit offers shielded windows that let you view equipment like analog meters, digital displays, CRTs, and teleprinters while effectively blocking EMI. The company's ECTC (electrically conductive transparent coating) windows, for instance, provide about 70% transmission of visible light and a 90-dB attenuation for electric fields at 10 MHz. Standard windows come in acrylic or glass, as large as 18 in. on a side. A glass window, measuring 1 ft², costs \$125.

Fuzz Buttons are one of many other EMI-shielding products from Tecknit. They are little wire-mesh pads designed to be resilient, low-impedance, multipath shielding/grounding elements. You mount the Fuzz Buttons using metal cups or threaded studs, and they provide static discharge, heat transfer, vibration and

Fundamentals of fields and waves

Maxwell, Faraday, and others formulated the basic equations describing electric and magnetic fields long before the age of electronics. Many of these equations, though, are based on bizarre abstractions: a point charge in space an infinite distance from all other point charges, for example, or a straight wire of infinite length parallel to and at distance d from an infinite metal plane.

But the geometry of actual hardware seldom allows direct use of the basic equations. How shielding actually affects electric and magnetic fields is better expressed in some empirically derived equations that have practical use in designing EMI shields.

A source of electromagnetic energy generates expanding spherical wave fronts that travel in all directions from the source, with a velocity near that of light. The wave at any point on the sphere consists of an electric field (E) and a magnetic field (H), which are perpendicular to each other and to the direction of propagation. Because the propagation medium, the surrounding objects, and the electrical characteristics and geometry of the source all affect the E and H fields, the field magnitudes generally vary around the surface of the sphere. Field magnitudes also determine the type and amount of shielding you'll need in a given system.

Wave impedance Z_w is one useful concept in thinking about EMI-shielding requirements. Analogous with Ohm's Law, Z_w equals the ratio of E to H. The current in a loop antenna, for example, flows in response to a relatively low drive voltage, and the resulting small E field and relatively large H field produce a low value of Z_w near the antenna. Such an antenna is called a

current source, a magnetic source, or a low-impedance source.

On the other hand, the operation of a quarter-wave stub antenna involves low current and relatively high voltage, creating a high-impedance wave near the antenna. But for all waves regardless of their origin, Z_w converges to a common value as the wave front propagates away from the source. At a distance of one wavelength, the wave impedance produced by a loop or stub antenna or any other source, approximates the intrinsic impedance of free space: 377Ω . (For reference, a wavelength at 1 MHz is 300m.)

Knowing the near-field Z_w of unwanted radiation helps you design against it. That is, you can shield against low-impedance waves below 200 kHz or so by using high-permeability ferromagnetic materials that divert the lines of magnetic flux. In contrast, you can shield against high-impedance waves (and most plane waves for that matter) by using high-conductivity metals that short out the wave's E-field vector.

In general, three mechanisms contribute to the effectiveness of a shield. Part of the incident radiation reflects from the shield's front surface; part is absorbed within the shield material; and part is reflected from the shield's rear surface to the front, where it can aid or hinder depending on its phase relationship with the incident wave. Shielding effectiveness SE, then, equals the sum of the reflection factor R, the absorption factor A, and the correction factor B for rear-surface reflections, all expressed in dB.

Shields reflect and absorb

The following equations let you calculate these three factors.

The greater a mismatch between the incident-wave Z_w and the shield's surface impedance, the more energy the shield reflects. (Thus, a thin sheet of high-conductivity copper has little effect on a low-impedance wave.) The reflection R (in dB) for an incident plane wave is

$$R = 108.2 + 10 \log \left(\frac{G + 10^6}{\mu f} \right),$$

where G is the shield's conductivity relative to copper, μ is the shield's relative permeability, and f is the frequency in Hz. Other equations (Ref 1) describe the reflection of electric (E) and magnetic (H) fields.

Shield absorption A (in dB) for incident E fields, H fields, or plane waves is

$$A = 3.338t\sqrt{\mu fG},$$

where t is the shield thickness in mils.

If A is 6 dB or greater, the shield's B factor for rear-surface reflection is negligible. B is significant only for thin shields and for frequencies below about 20 kHz:

$$B = 20 \log \left| 1 - \frac{(K-1)^2}{(K+1)^2} \left(10^{-\frac{A}{10}} \right) \left(e^{-j(0.227A)} \right) \right|,$$

where j equals $\sqrt{-1}$ and

$$K = \left| \frac{Z_s}{Z_H} \right| = 1.3 \sqrt{\frac{\mu}{fr^2G}},$$

where Z_s is the shield impedance, Z_H is the impedance of the incident magnetic field, and r is the distance from the source to the shield in inches.

It is customary to neglect all but the A term when designing a magnetic shield, particularly for frequencies below 14 kHz. Similarly, you can neglect all but the R term when shielding against E fields or plane waves.

Conductive thermoplastics are attracting renewed attention for use in EMI and ESD control.

shock dampening, and low-closure-force gaskets. Available in phosphor bronze, monel, and silver-brass, they cost from \$0.75 to \$1 in OEM quantities.

EMI-shielding products let you build or maintain your own enclosure. But the construction of larger walk-in chambers and screen rooms is better handled by specialists who can deliver a prefabricated unit with guaranteed shielding performance. Ray Proof, for example, is the world's largest manufacturer of RF-anechoic chambers (Fig 1) and RF enclosures, according to Frost & Sullivan.

Double-shielded RF enclosures

Lindgren RF Enclosures also specializes in RF-shielded enclosures, from table-top models to walk-ins. They feature a patented clamping technique for assembling the modular wall panels, and they come in single-shield or double-electrically-isolated (DEI) configurations. DEI construction provides additional protection by supplying two insulated EMI barriers, separated by 1¼ in. typ, in the walls, ceiling, and floor. The barriers are electrically connected at only one point.

Lindgren's DEI screened enclosures are 8 ft high and 10 ft wide with lengths from 12 to 42 ft. Suitable for EMI testing in accordance with FCC, Tempest, and

various MIL-STD regulations, the rooms come with either copper or bronze screening. Price for a 14-ft-long enclosure is \$8075 (bronze screen) or \$8652 (copper screen).

For suppressing EMI at the pc-board level, Fair-Rite Product Corp makes ferrite shielding beads in addition to ferrite products of all types—rods, slugs, pot cores, disks, and toroids. In bead form, threaded onto an insulated wire, the lossy ferrite material can attenuate high-frequency EMI while allowing lower signal frequencies to pass unaffected.

Ferrite beads swamp interference

Fair-Rite's nickel zinc beads (designated #43), for instance, present a maximum impedance (50 to 65Ω) in the range from 30 to above 200 MHz. The company claims that most computing equipment generates little EMI above 200 MHz; it therefore recommends these beads for use in such digital equipment. They cost \$40 to \$150 (100), including setup charge. For other applications, you can choose beads of #73 or #64 material, whose impedance peaks at 25 and 500 MHz, respectively.

Equally useful are Fair-Rite's multiturn beads, multihole beads (for multiple wires), and the split

For more information . . .

For more information on the shielding products mentioned in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service Card.

Advance Magnetics Inc
625 Monroe Street
Rochester, IN 46975
(219) 223-3158
TWX 810-290-0294
Circle No 614

Ammuneal Manufacturing Corp
4737 Darrah St
Philadelphia, PA 19124
(215) 535-3000
Circle No 615

Atlantic Research Corp
5390 Cherokee Ave
Alexandria, VA 22312
(703) 642-4023
TLX 248893
Circle No 616

Atlee Inc
10 Bayfield Dr
North Andover Business Park
North Andover, MA 01845
(617) 681-1003
Circle No 617

Chomerics Inc
77 Dragon Ct
Woburn, MA 01888
(617) 935-4850
TWX 710-393-0173
Circle No 618

Compliance Engineering
593 Massachusetts Ave
Boxborough, MA 01719
(617) 264-4208
Circle No 619

Dash Strauss & Goodhue Inc
593 Massachusetts Ave
Boxborough, MA 01719
(617) 263-2662
Circle No 620

Eagle Magnetic Co Inc
Box 24283
Indianapolis, IN 46224
(317) 297-1030
Circle No 621

Fair-Rite Products Corp
Box J
One Commercial Row
Wallkill, NY 12589
(914) 895-2055
TWX 510-249-4819
Circle No 622

Lindgren RF Enclosures
1228 Capitol Dr
Addison, IL 60101
(312) 628-9100
Circle No 623

Norand Corp
550 Second St SE
Cedar Rapids, IA 52401
(319) 366-7611
Circle No 624

Perfection Mica Co
Magnetic Shield Div
740 N Thomas Dr
Bensenville, IL 60106
(312) 766-7800
Circle No 625

Ray Proof
Div of Shielding Systems Corp
Box 5060
Norwalk, CT 06856
(203) 838-4555
TLX 965812
Circle No 626

Tech-Etch Inc
45 Aldrin Rd
Plymouth, MA 02360
(617) 747-0300
Circle No 627

Tecknit
129 Dermody St
Cranford, NJ 07016
(201) 272-5500
Circle No 628

Wilson-Fiberfil International
Box 3333
Evansville, IN 44732
(800) 457-3764 (812) 424-3831
TLX 752708
Circle No 629

*Neither rain, weak batteries,
rough handling, nor blazing sun
shall stay these wands...*



Does your customer's application push ordinary scanners beyond their limits? Relief is at hand. HP's new family of ultra-dependable, low-current bar code wands will fulfill their appointed rounds on loading docks, in store aisles...any application where this type of scanner might be used. And, never has such a rugged family of HP scanners been offered at such competitive prices.

Supply current is a *constant* 3.5 mA without strobing or special software; switched versions draw zero current when not in use. High ambient light rejection permits use in full sunlight. Available in metal (HBCS-6000 Series), plastic or switched plastic versions (HBCS-5000 Series), these wands are ergonomically

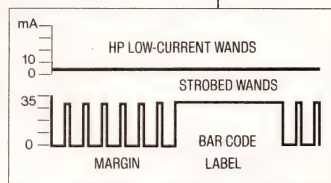
designed for a sure, comfortable grip.

Each is available in three resolutions to scan everything from poorly printed labels to dense code.

Our industrial models are repetitively shock-resistant up to 500 G's with multiple "O" ring seal construction and replaceable sealed sapphire tips. (Use them in the rain!)

Designed for the "real world," all operate from -20° to 65° C and reliably, repeatably read a wide range of inks and contrast levels over a 45° angle. Projected MTBF? Over 37,000 hours. Price: \$110 to \$123* depending on model.

For the hard-number results on our reliability testing and data sheets, circle the bingo number below on the reader service card. *U.S. list price in quantity of 100.



HP wands minimize power drain.

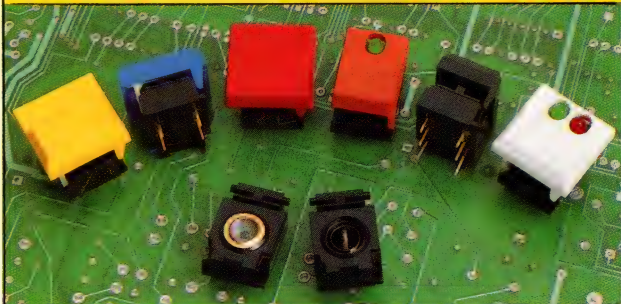
For more information, call the Hewlett-Packard sales office listed in your telephone directory white pages and ask for the Components Department. To order, contact your nearest HP distributor. In the U.S.: Almac Electronics, Hall-Mark, Hamilton/Avnet, or Schweber. In Canada: Hamilton/Avnet or Zentronics Ltd.

CG08706

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PACKARD

SIGMATAST

HIGH QUALITY INPUT SWITCH IN MINIATURE



Desirable standard features are less than 2ms contact bounce, 5,000,000 cycle life and gold contacts.

Two LED's and 21 different cap styles offer designers unlimited flexibility. Watertight version available. Custom engraving upon request. Why put up with our competition's 12 week or more lead times? We'll meet your production schedules!

Send for samples and price information.

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ELECTRONIC COMPONENTS GROUPE

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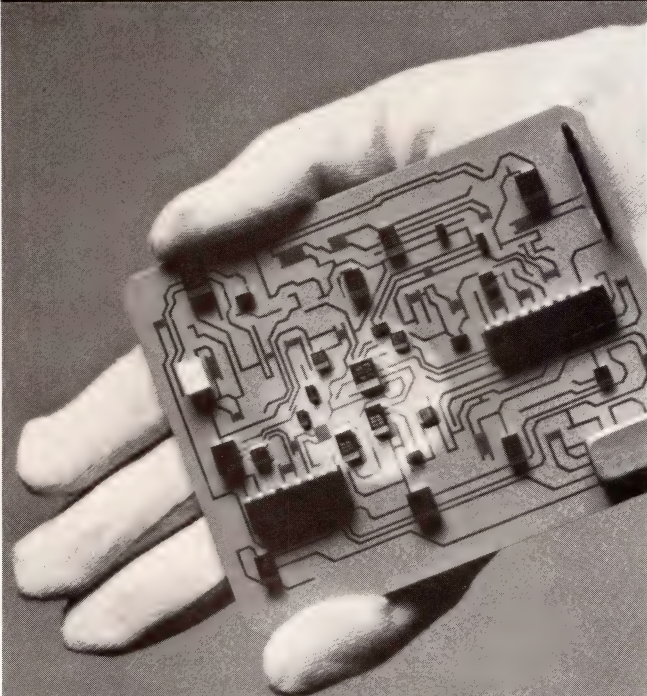
800/826-8719

612/375-9639

TWX 62985650 FAX 612-375-1905

CIRCLE NO 29

TANTALUM CHIP CAPACITORS FOR SURFACE-MOUNT DEVICES



MATSUO ELECTRONICS

2134 Main Street, Suite 200 (714) 969-2491

Huntington Beach

FAX (714) 960-6492

California 92648

TWX (910) 596-1828

CIRCLE NO 30

suppressors, which encompass entire flat cables. The split flat-cable devices present 150Ω at 100 MHz and cost \$0.30 to \$0.90 (10,000). The company also offers surface-mounted ferrite beads for suppressing EMI on a single pc trace. These come in a 45 or a 90Ω version (impedance at 100 MHz) and cost \$0.05 to \$0.07 (10,000).

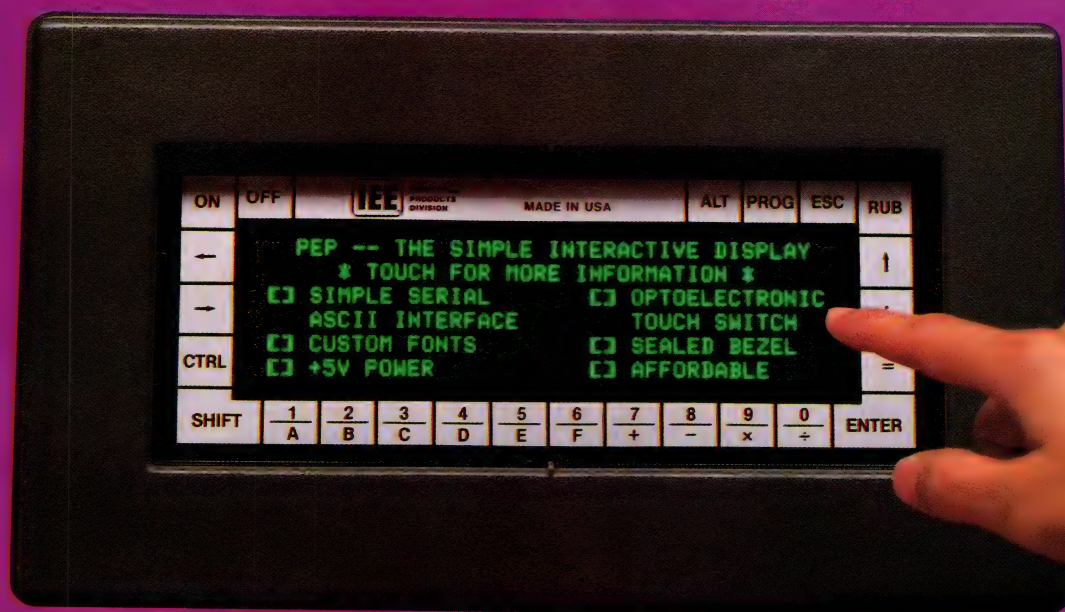
Finally, when you need to enclose a noisy board-level component like a transformer or a switching transistor, you can turn to Atlee Inc. Atlee's small EMI boxes and vertical barriers (walls) have tabs that let you solder them directly to the pc board. By containing EMI at the source, these standard and custom products can sometimes reduce the need for more expensive, overall shielding. Prices range from \$2 to \$10 (500). **EDN**

References

1. Cowdell, Robert B, "Nomograms simplify calculations of magnetic shielding effectiveness", *EDN*, September 1, 1972, p 44.
2. *EMI Shielding Engineering Handbook*, 1987, Chomerics Inc, Woburn, MA.

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478

Everything You Need In A Touchscreen Display



(hand not included)

“Everything” is no exaggeration when you’re talking about **IEE’s new PEP/VF™ Model 4283**. We started with a bright 6-line by 40-character vacuum fluorescent display that is easily filterable to a variety of eye-pleasing colors. On top of that we added an **opto-electronic** touchscreen for superior display appearance. But that’s not all—the list goes on:

- Fits where a CRT can’t—only 1.55” deep from panel surface
- Low power operation—operates from a single +5VDC power supply

- Simple serial ASCII interface (RS-232-C, RS-422-A)
- Single-piece construction, with environmentally-sealed bezel
- Optional custom overlays define user-dedicated switch positions
- Host overhead is reduced by on-board “canned-message” RAM

And all this at an affordable price!

So, call or write us today about our **PEP/VF** Interactive Display Module, and we’ll give you a “hand”... figuratively speaking, of course!



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FAX: (818) 902-3723 (G2/G3)

IEE LIMITED, Unit 6, Park Industrial Estate, Frogmore, St. Albans, Hertfordshire AL2 2DR UK Tel. 0727 74376/Telex: 264992 (G)/FAX: 0727 74300

Circle 4 for Immediate Application

Circle 43 for Reference Material

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Because we manufacture and stock the 101 and 102 at three different locations around the world, you won't have to wait for delivery. Regardless of your deadline or location.

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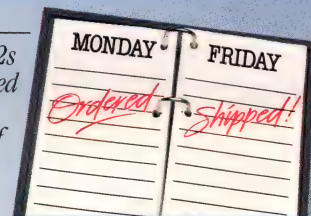


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The Responsive Input Company



The Key Tronic 101 Keyboard.

Components

Phone-book-size servo amplifier specs $\eta=98\%$ at 4.5-kW output

The Model 241 servo amplifier uses pulse-width modulation to control the power delivered to its load. It dissipates 77W when it delivers 4.5-kW load power, so it's satisfied with air cooling.

Measuring 6.5×10.5×2.4 in., the 241 delivers $\pm 150V$ at $\pm 30A$ continuous and $\pm 60A$ pk to motor loads. These figures correspond to 6 and 12 hp, respectively. The amplifier's 22-kHz switching frequency eliminates audible hum. This frequency also lets you use the unit to drive low-inductance motors without adding any external inductance.



Accepting 24 to 165V power supplies, the 241 offers full 4-quadrant operation. For most duty cycles, you need no external heat sink. For applications that require heat sinking, the manufacturer offers a mating

heat sink. The amplifier contains fail-safe circuitry that protects the unit against damage from output overloads, excessive temperature rise, and improper power-supply voltages.

An internal dc/dc converter allows you to operate the 241 from a single-ended supply. Variable current limiting in the amplifier is adjustable from 5 to 100% of peak rated current. \$990.

Copley Controls Corp, 375 Elliot St, Newton, MA 02164. Phone (617) 965-2410. TLX 285957.

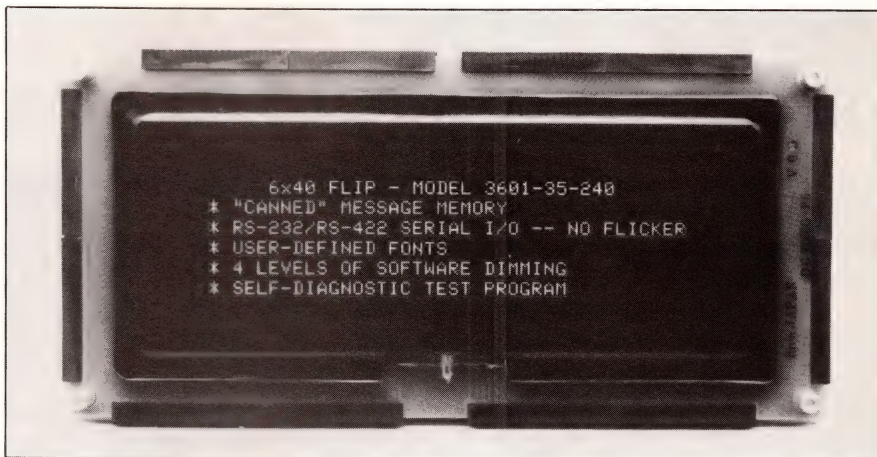
Circle No 552

Vacuum-fluorescent display with CMOS RAM features canned messages, battery backup

Model 3601-35-240, an addition to the Flip family, is a 6-line×40-character vacuum-fluorescent display with the ability to store and retrieve user-programmed canned messages. The module's 8k-byte CMOS RAM can store as many as 127 messages, and an onboard battery-backup circuit retains the messages.

The display also features an integral self-diagnostic test program that checks all display functions. This program checks and displays user settings for data configuration and rate, the condition of the battery-backup circuit, the line drivers and receivers, and the RAM available for canned messages. At the conclusion of the test, the module displays its repertoire of 96 ASCII characters.

In addition to the standard ASCII set, the module can display alternate character sets (for example,



scientific, Scandinavian, and German). You can also download user-defined character patterns into any or all of the 96 ASCII locations.

The 3601-35-240 operates from one 5V supply. An onboard μP controls all display functions and the serial data interface with the host system. This interface can conform to either RS-232C or RS-422C

standards and can accept data at 1200 or 9600 baud. Each of the display's 240 5×7 dot-matrix characters is 5 mm high. \$538 (100). Delivery, four to six weeks ARO.

IEE Inc, Industrial Products Div, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311.

Circle No 557

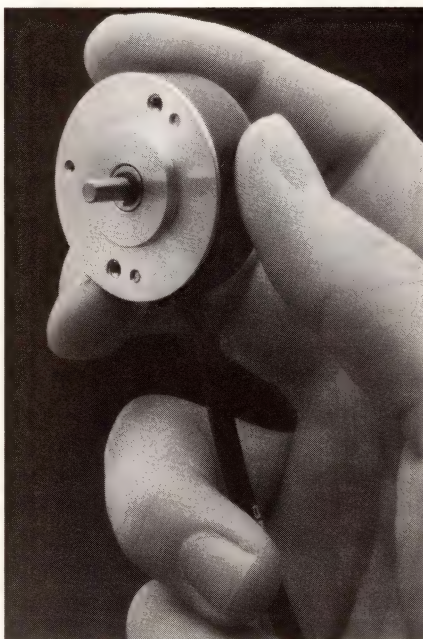
Components

Compact magnetic rotary encoder operates in harsh environments at 5000 rpm

The Model RE10 magnetic rotary encoder employs high-density magnetic materials to achieve its compact size—14.3 mm thick by 38.5 mm in diameter. You have seven angular resolutions to choose from, ranging to 2048 counts per revolution; the maximum rotational speed is 5000 rpm.

The lightweight unit (40g) comes in a protective, shielded case; you can design it into tight spaces with little concern for the accumulation of dirt, splashes of oil, and other hazards that would degrade the reliability of optical encoders.

Whether the RE10 is operating as a tachometer or as a shaft-position encoder, it connects to the host equipment via a universal coupler



and rotor shaft. The encoder accommodates radial and axial shaft loads of 1 and 0.5 kg, respectively. The maximum output frequency of any of the available seven models is 100 kHz.

The encoder operates from a 5V supply and consumes 150 mW max. Its operating range spans -10 to +60°C, and the maximum operating humidity equals 95%. The required starting torque is 10 g-cm max; the shaft, wheel, and bearings produce a 2.5 g-cm² max moment of inertia. The encoder costs \$111; the coupler sells for \$9.

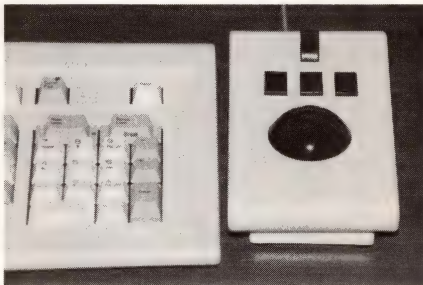
**National Machine Systems Inc.,
137 Bristol Lane, Orange, CA
92665. Phone (714) 921-0630.**

Circle No 556

Low-cost trackball eliminates jitter, offers 3-dimensional I/O control for CAE

You can use the FastTrap pointing device to inject X-, Y-, and Z-axis data directly into a variety of application programs. It occupies only 18 in² of desk space, doesn't require a special work-surface texture, isn't as sensitive to dust as mice are, and eliminates the jitter that mice often cause in high-resolution applications.

Each unit houses a 200-pulse/in. trackball for X- and Y-axis input and a 200 pulse/in. fingerwheel for Z-axis input. The FastTrap device emits pulses to indicate motion in each axis; your application software interprets the trackball movements to change the position of the screen cursor.



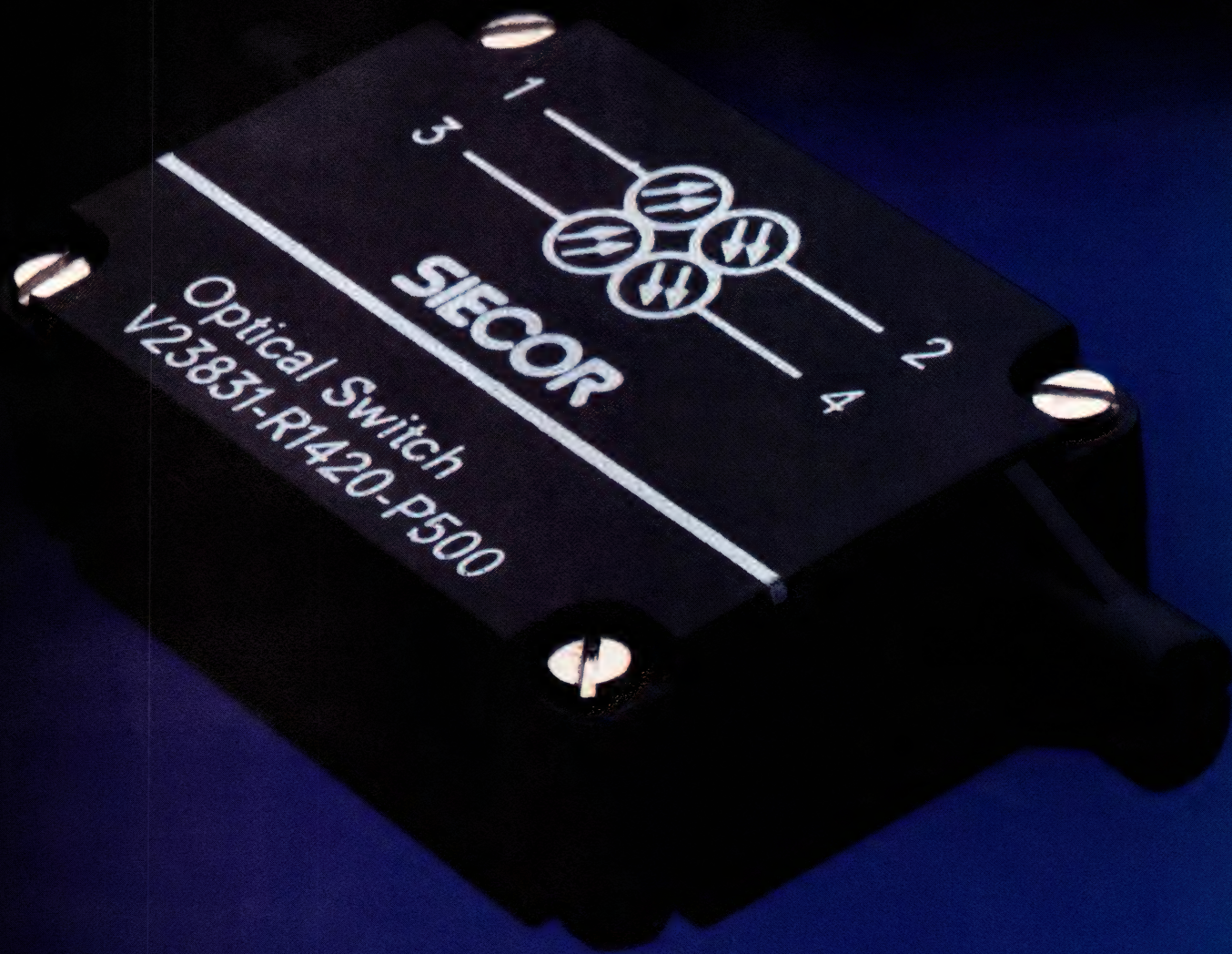
FastTrap plugs into the serial port of any IBM PC or compatible computer via its RS-232C interface. The device comes with an MS-DOS/PC-DOS software driver for ease of installation. To provide compatibility with existing software, FastTrap includes hardware emulation of mouse controllers. Three buttons enable you to make menu selections,

and you can adjust the tracking drag to suit your application.

Some CAE/CAD software packages (such as AutoCAD) offer 3-dimensional capability, but with an ordinary mouse or trackball you have to enter all Z-axis information from the keyboard. By integrating a FastTrap device into your CAE/CAD system, you can enter the Z-axis information with the pointing device and thereby enhance the functionality of your 3-dimensional software. \$149.

**MicroSpeed Inc., 5307 Randall
Pl, Fremont, CA 94538. Phone
(800) 232-7888; in CA, (415) 490-
1403.**

Circle No 554



We Tried A Hundred Million Times To Get This Switch To Fail.

To prove its repeatability, we subjected our fiber optic switch to a hundred million operations in laboratory tests. And true to form, it maintained 0.1 dB repeatability at a typical insertion loss of 0.7 dB. And not just any switch can do that.

But our switches pass tough environmental tests such as vibration, shock and temperature extremes. They offer high switching rates. And they're so flexible they can be used in 850 nm or 1300 nm wavelength systems. They're also available in all popular fiber sizes. And they come in a compact, lightweight package.

We offer this kind of performance and practicality in all our electro-optic products including our high speed data links, clock recovery modules, clock oscillators, parallel/serial converters and fiber optic modems (RS232, RS422 and TTL).

To find out all the reasons you should be using Siecor components, get in touch with us soon. And we'll give you about a hundred million of them. Write Siecor Corporation, Electro-Optic Products, P.O. Box 13625, Research Triangle Park, North Carolina 27709-3625. Or call 919 549-6571.

SIECOR

Components

Fast bipolar power transistors rival high-voltage MOSFETs, simplify circuitry

You can use bipolar ETD (Easy-To-Drive) power transistors at switching frequencies as high as 100 kHz, suiting the devices for use in off-line switch-mode power supplies. You have a choice of eight npn transistors with IC_{SAT} voltage ratings measured at 10 and 20A and breakdown voltage ratings of 400V (working) and 850 or 1000V (peak).

Capable of operating without negative base drive, ETD transistors switch as fast as conventional bipolar transistors with negative base drive, allowing you to simplify base drive circuitry. Without the negative base drive, they have a maximum fall time of 150 nsec at 100 °C.

By employing negative base drive, however, the transistors can achieve fall times as short as 40 nsec—making them suitable for ap-



plications that previously would have required power MOSFETs. In addition, their extended RBSOA (reverse-biased safe operating area) allows you to use them with smaller snubber components, or without

any snubber components at all.

ETD transistors are available in TOP-3 and isolated TOP-3 packages. The isolated TOP-3 package can withstand 2500V rms between its case and its connection pins. Selling prices for the transistors are typically 15 to 25% more than prices for conventional bipolar transistors with the same current and voltage ratings. For example, the BUF410, a 10A/850V transistor, costs around 11 Fr fr (10,000).

Thomson Semiconducteurs, 45 Ave de l'Europe, 78140 Velizy, France. Phone (1) 39469719. TLX 204780.

Circle No 558

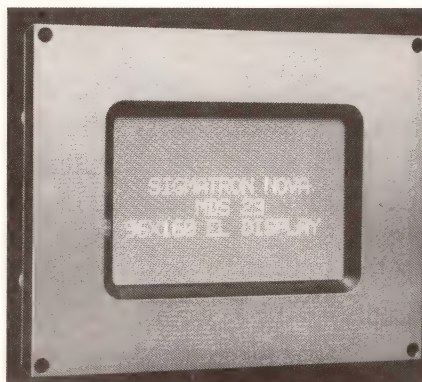
Thomson Components-Mostek Corp, Commerce Dr, Montgomeryville, PA 18936. Phone (215) 362-8500. TWX 510-661-6548.

Circle No 559

EL display with 225-fL pixel intensity and V_D of 170V is readable in sunlight

The MDS-23 electroluminescent (EL) display achieves an unfiltered pixel intensity of 225 fL at a drive voltage of 170V and a refresh rate of 300 Hz. This intensity level makes the display readable in sunlight, so it's suitable for environments such as airplane cockpits and brightly lit factory floors.

The display consumes 0.3W/in² typ, has a 160° viewing angle, and a 10-μsec response time. In room lighting, the contrast ratio equals 20:1; this ratio decreases as the ambient light increases. In ambient lighting of 10,000 fL, (the maximum



ambient brightness the military specifies for high-altitude shaft lighting), you can achieve a contrast ratio of 3:1 by using the display with

a polarized filter.

The MDS-23 measures 2×3 in. and supports a 96×160-dot matrix. Standard versions of the display cost \$475 with drive electronics and \$375 without drive electronics. The manufacturer also offers an engineering evaluation kit containing the MDS-23 display with drive electronics, a controller card with serial and parallel interfaces, and a power supply for \$2585.

Sigmatron Nova Inc, 1901 Oak Terrace Lane, Thousand Oaks, CA 91320. Phone (805) 498-4504.

Circle No 553

BLENDING TECHNOLOGIES.



SMART
POWER

SPRAGUE SUPPLIES SMART POWER.

Sprague continues its combination of bipolar power and CMOS logic in more innovative ways in its second and third generation of BiMOS power drivers (Series UCN-5800 and UCN-5900). These new devices excel in driving print heads and stepper motors as well as electroluminescent, plasma, and vacuum-fluorescent displays. They switch voltages up to 200 V, and drive loads to 2 A per channel, with up to 32 channels per chip. CMOS shift registers, latches, and decoders are incorporated for easy μ P interface. Features and advantages include high input impedance, good noise immunity, wide logic supply range (5 to 12 V), and high data input rates (3 to 5 MHz).

Sprague Electric Company, a Penn Central unit. Semiconductor Group, Worcester, MA. For applications assistance, call 800/247-2077 (in Mass., 800/247-2076). For Brochure WR-203 write to Technical Literature Service, Sprague Electric Company, P.O. Box 9102, Mansfield, MA 02048-9102.



CIRCLE NO 111

4SS-5114RI

Components

Digital panel meter interfaces directly to thermocouples and displays five digits

The PM-5050 connects directly to thermocouple types B, E, J, K, N, R, S, and T. Its internal circuitry filters, amplifies, and converts the thermocouple's voltage to a direct temperature readout in units of °C or °F. You can choose a resolution of either 1° or 0.1° for the 5-digit display.

The meter measures temperatures over the entire ANSI-specified range for each thermocouple type. It also provides cold-junction compensation. Besides measuring temperature, the meter controls four independent setpoints, each of which activates a MOSFET. Each optically isolated MOSFET



switches a maximum of 100 mA at 300V.

Four front-panel membrane switches let you select options from a menu that scrolls through the meter's alphanumeric display. Menu

items let you establish setpoint temperatures, set a hysteresis value, test the meter, and control its RS-232C port.

The RS-232C port lets you connect the meter to a remote computer system. Because you can set each meter to respond to a 2-digit identification code, as many as 100 meters can connect to one RS-232C port on your computer. Various models operate on 115V, 230V, or 100V ac, or 5V dc; all consume less than 4W under normal operation. \$395.

GE Datel, 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TLX 951340.

Circle No 555

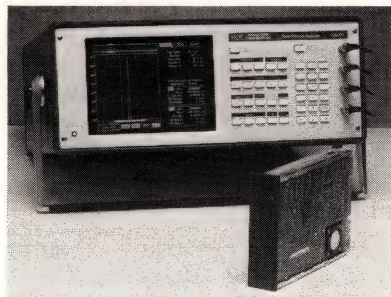
Place Your Bits.

Keeping book on bit shift is more difficult than ever for today's high-performance drives. That's where our new TIA-175™ Time Interval Analyzer comes in. For fast and accurate realtime measurement of bit shift, margin and error rate in floppy, hard and optical disk drives and tape drives. It has powerful software support for all popular encoding methods, and ties directly into drive electronics for use with all interfaces including SCSI and ESDI.

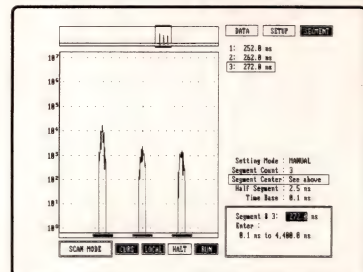
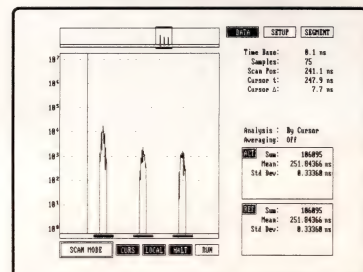
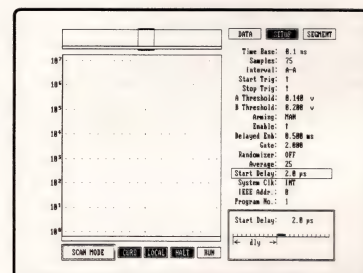
The TIA-175 features a minimum time between measurements of less than 1 µs with highly accurate 100 ps resolution. This eliminates time-consuming error rate testing while providing a realtime picture of drive performance at data rates up to 50 Mbits per second.

For disk drive development and research, service or incoming test, the TIA-175 offers a host of easy-to-use features. Results are displayed in histogram form with automatic analysis. On-screen displays make operation simple and fast.

For more information on placing your bits with ADC's new TIA-175, call toll-free (800) 221-5486; in California, (800) 334-5486.



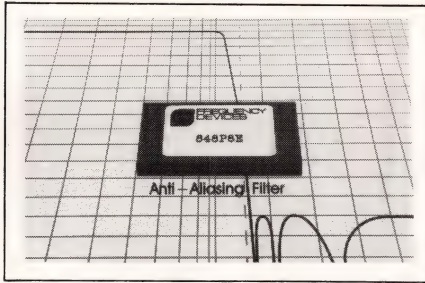
ADC APPLIED DATA COMMUNICATIONS



14272 Chambers Road, Tustin, CA 92680-6998 • (800) 221-5486 In California (800) 334-5486 (714) 731-9000

CIRCLE NO 31

Components



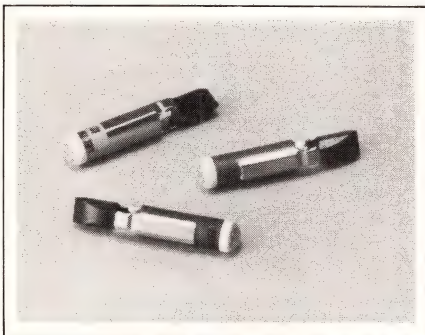
FILTER MODULES

The 848P8E Series digitally programmable, 8-pole, 6-zero elliptic lowpass filters feature sharp roll off beyond the passband. Over a frequency span of just 1.77, attenuation increases from -0.03 dB at the stopband edge to -80 dB at the stopband floor. External CMOS-level commands set switches and RC combinations to select the filter corner frequency. Five models offer five factory-set tuning ranges: 0.1 to 25.6 Hz, 1 to 256 Hz, 10 to 2560 Hz, 100 to 25.6 kHz, or 200 to 51.2 kHz.

All filter modules have a non-inverting dc gain of 0 ± 0.2 dB. A 20-k Ω input impedance, a 10 Ω output impedance. The ability to operate from ± 12 to ± 18 V supplies simplifies module use. \$300.

Frequency Devices Inc, 25 Locust St, Haverhill, MA 01830. Phone (617) 374-0761. TWX 710-347-0314.

Circle No 690



LED LAMP

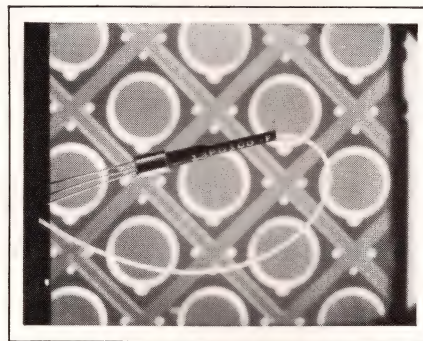
Model 55SB206 comes with a built-in resistor and reverse-protection rectifier so it can operate on voltages from 5V dc to 120V ac. This lamp is a direct replacement for the T5.5 telephone-slide incandescent lamps. It's rated for 100,000 hours

and has a 160° viewing angle. The main LED is made of six chips placed and wire-bonded onto a ceramic base. Three color outputs are available: red, yellow, and green.

The 5 and 6V versions have a current drain of 20 mA per chip; these devices have the chips connected in three parallel circuits so total current drain is 60 mA. The 12 and 14V units have two parallel circuits of three chips; thus, the current requirement is 40 mA. The 24 and 28V models have all their chips wired in series, so current drain equals 20 mA. The LED is also available without built-in resistors to satisfy applications where resistors are already in the circuit. \$3.60 (1000).

Ledtronics Inc, 4009 Pacific Coast Hwy, Torrance, CA 90505. Phone (213) 676-7996. TLX 4945454.

Circle No 691



OPTICAL DETECTOR

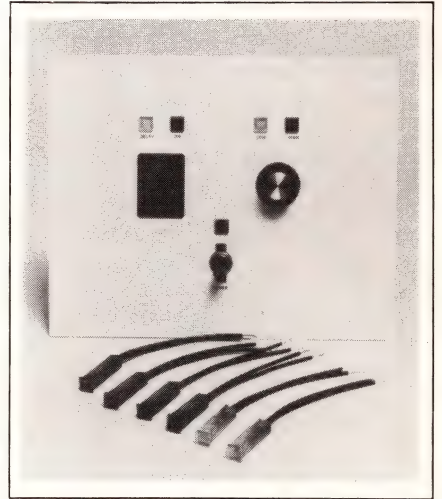
The 13PD100-F optical detector is available with a range of fiber-pigtail and connector options. It's housed in a modified TO-46 can with three leads for anode, cathode, and case. The detector's photosensitive area measures 100 μ m in diameter. Dark current (at 23°C and with 5V bias) is 10 nA max, and capacitance equals 1.5 pF max. Rise and fall times are less than 1 nsec at 23°C, and minimum responsivity measures 0.7A/W (0.8A/W typ).

Absolute maximum ratings are 30V reverse voltage, 5-mA forward current, and 500- μ A reverse current. Operating range spans -40 to

$+85^\circ\text{C}$. To ensure reliability, the device is burned-in at 200°C for 15 hours at 20V bias. \$168 (100) for a unit with a 50/125- μ m multimode-fiber pigtail.

Telcom Devices Corp, 914 Tourmaline Dr, Newbury Park, CA 91320. Phone (805) 499-0611.

Circle No 692



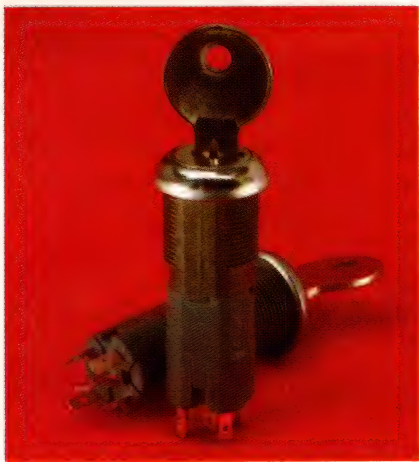
INDICATORS

These indicators, the 5900 Series, feature a low-profile square lens. The devices simply snap into a $\frac{5}{16}$ -in. square hole in the front panel of the equipment. The indicators are available in 12 off-the-shelf models, including neon types in three colors for both 125 and 250V ac operation and LED versions in three colors for 12 and 24V dc operation. Neon models include built-in current-limiting resistors. LED versions come with current-limiting resistors and protective rectifier diodes.

Indicator housings are tamper-proof and rugged. The overall indicator assembly measures about $\frac{1}{4}$ in. square by approximately $1\frac{1}{2}$ in., and will snap into panels that are $\frac{1}{4}$ to $\frac{1}{8}$ in. thick. Wire-lead terminations are standard, but you can order units with terminals. A neon version, Model 5900K1, costs \$0.65 (1000).

Industrial Devices Inc, 7 Hudson Ave, Edgewater, NJ 07020. Phone (201) 224-4700.

Circle No 693



Anti-Static Keylock Switches For All Ratings To 4 Amps @ 120 V.A.C.

Oak anti-static keylock switches protect sensitive electronic circuitry from inadvertent static discharges of up to 20 KV. They can be used for operating voltages from dry circuits to 4 amps at 120 V.A.C. These switches also provide equipment security from unauthorized users. Market applications include CRT terminals, point-of-sale terminals, credit verifications systems, bank teller systems and security systems.

Only 2-1/2 inches long, the Oak anti-static keylock switch will fit a .760 diameter x .635 double flattened cutout. Oak anti-static keylock switches are UL and CSA listed and are available in a wide range of key options.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 107



Low-Profile, Full Travel Membrane Based Keyboards

Oak's Low-Profile FTM uses an optimized keymodule that provides improved consistency, better feel and lower cost per keystroke position. DIN compatible, Oak FTM keyboards are designed for high speed data entry systems that require long life and operator comfort.

The patented switch design has a profile of just 19.9 mm (0.785 inches). Operating (finger) forces of the keystroke are available from .9 to 6 ounces. The keyswitch features only four parts providing extremely high reliability - in excess of 50 million cycles.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 146

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Oak Switch System's extensive line of rotary and linear solenoids include box frame, tubular, flat pack, and rotary selector. All are engineered and manufactured to meet stringent quality standards.

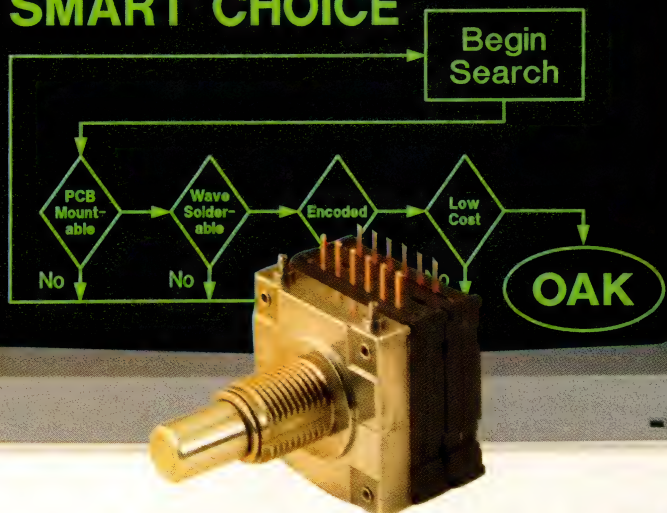
Oak has standard solenoids for virtually any force/stroke requirement. Oak engineers will also custom design rotary or linear solenoids to meet client specifications.

Contact: Oak Switch Systems Inc.
P.O. Box 517
Crystal Lake, IL 60014
Phone: 815/459-5000

CIRCLE NO 185



SMART SWITCH... SMART CHOICE



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Oak's complete family of high-quality programmable, subminiature, keylock, lever and open and closed-frame rotary switches provide the multi-function accuracy and intelligence you need in sensitive switching applications. These rugged and reliable switches come in a variety of standard sizes and can be custom engineered to meet any design parameters.

All Oak rotary switches are designed to provide precise, consistent and highly-reliable contacts - cycle after cycle - most of them are qualified to MIL-S-3786. In addition, many feature Oak's patented Unidex® detent system with dual-wiping, self-cleaning contacts.

Oak rotary switch options include:

- Fixed or adjustable stops and a variety of indexing options
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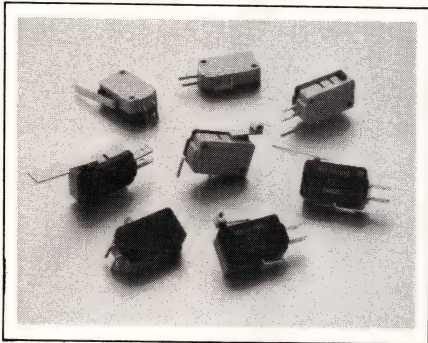
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CIRCLE NO 224

Components

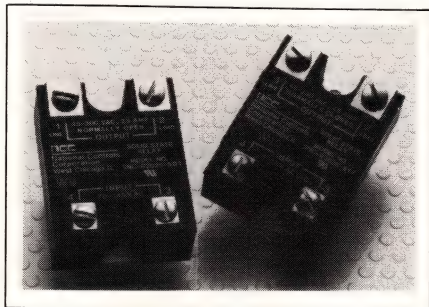


SWITCHES

TF Series switches are directly interchangeable with most snap-acting switches. They measure 1.14×0.40×0.62 in. and mount on 0.88-in. centers. Designed to meet to UL and CSA requirements, the switches are available with electrical ratings from dry circuit to 25A at 125/250V ac. All plastic components have a 94V-0 UL flammability rating. Various standard and custom actuators are available. Operating forces of 15 to 400g are standard for basic switches, as are quick-connect and pc-board terminal configurations. From \$1.07 (1000). Delivery, eight weeks ARO.

C&K/Unimax Inc., Box 152, Wallingford, CT 06492. Phone (203) 269-8701.

Circle No 694



SOLID-STATE RELAYS

R2025 Series solid-state relays can switch loads ranging to 25A. Each unit includes snubber circuitry to accommodate high dv/dt applications and inductive loads (with power factors ranging to 0.5).

Each relay employs a 40A output device to provide increased turn-on surge capability. Two input-control voltage ranges are available (3 to

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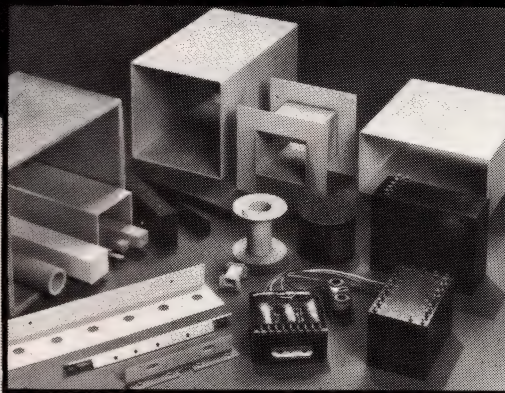
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CIRCLE NO 32

TRIMMERS

POWER SUPPLY COMPONENTS



HI-REL APPLICATIONS

GLASS EPOXY - 155°C
MIL-C-9084 • MIL-R-9300B • UL-94V-0

GLASS SILICONE - 180°C
GLASS POLYIMIDE - 240°C

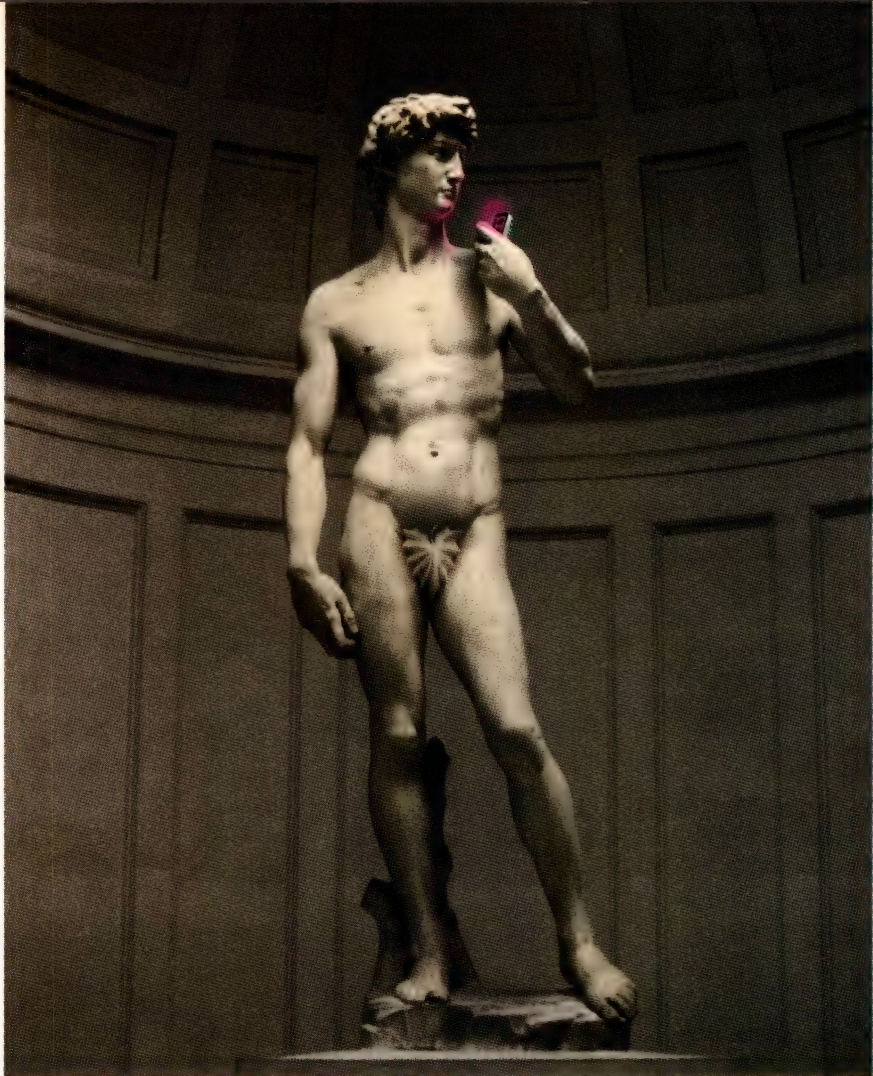
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CIRCLE NO 35



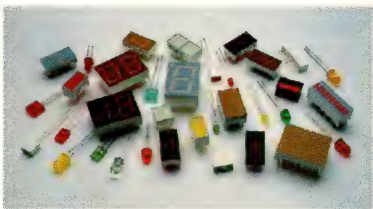
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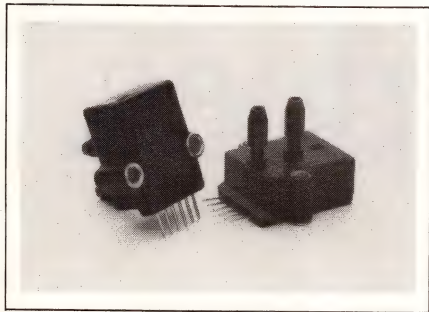
Distributors: Arrow, Bell Industries-Graham Division, CAM/RPC, Future, Hammond, J.V. Electronics, Kierulff, Milgray, Newark, Pioneer, Summit, Wyle.
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Components

30V ac/dc and 70 to 140V ac) in Form A (spst NO) or Form B (spst NC) output configurations. Controlled by a single CMOS gate, the dual SCR-type output can switch loads ranging from 48 to 300V ac. Optical-coupling techniques provide 4000V isolation. Maximum response time equals 50 msec. The relays are UL recognized and CSA certified. They have a -40 to +80°C operating range and feature zero-voltage turn-on. \$25.50.

National Controls Corp, 1725 Western Dr, West Chicago, IL 60185. Phone (800) 323-2593; in IL, (312) 231-5900.

Circle No 695



PRESSURE SENSORS

SCX Series pressure sensors include absolute, differential, and gauge devices with measurement capabilities from 1 to 100 psi max. When operating from 12V supplies, the sensors' zero-pressure offset is 300 μ V max with a shift over temperature (0 to 70°C) of 100 μ V. Full-scale span is trimmed to a tolerance of $\pm 1\%$ max, and span change over temperature is guaranteed to be less than $\pm 1\%$. The 4-k Ω impedance guarantees the low power dissipation required for portable and battery-operated equipment.

The output voltage is ratiometric to the supply voltage, with full-scale outputs ranging from 18 mV for low-pressure units to 100 mV for the higher-pressure devices (with 12V supplies). The sensors are capable of operating with supply levels ranging to 30V. Typically, accuracy is better than 0.1% full scale. The series is also available in commercial-

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CIRCLE NO 33

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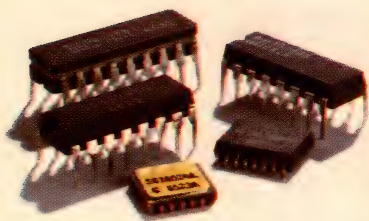
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SG1525AJ	SG3525AN
SG1526J	SG3526N
SG1527AJ	SG3527AN
SG1840AJ	SG3840AN
Current Mode	
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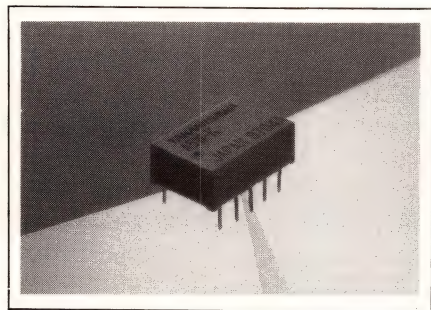
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grade C versions for applications where extreme precision isn't critical. SCX Series, \$22.50; C versions, \$15 (100).

Sensym Inc, 1255 Reamwood Ave, Sunnyvale, CA 94089. Phone (408) 744-1500. TLX 176376.

Circle No 696



DIP RELAY

The Type A space-saving relay is designed for telecommunications applications and measures only 0.551×0.354×0.197 in. It features dpdt (two Form C) bifurcated silver-palladium, gold-clad contacts, and its power consumption is 140 mW (nominal). Initial contact resistance equals 100 mΩ. The relay switches 1A at 30V dc or 0.5A at 125V ac resistive. It has a specified lifetime of 500,000 operations at 1A/30V dc and 200,000 operations at 0.5A/125V ac. Operate and release times are 2 and 1 msec, respectively.

Coil-voltage specs vary from 4.5 to 24V dc. Insulation resistance at 500V dc is 10⁹Ω min, and dielectric strength is 1000V ac between open contact, coil to contact, and adjacent contact. Surge strength equals 1500V, and operating range spans -40 to +70°C at nominal voltage. \$2.20 (1000). Delivery, eight to 10 weeks ARO.

ITT Components, 1201 E McFadden Ave, Santa Ana, CA 92705. Phone (714) 836-0351.

Circle No 697

DIP SWITCHES

K40 DIP switches meet telecommunications requirements and are available with two to eight positions

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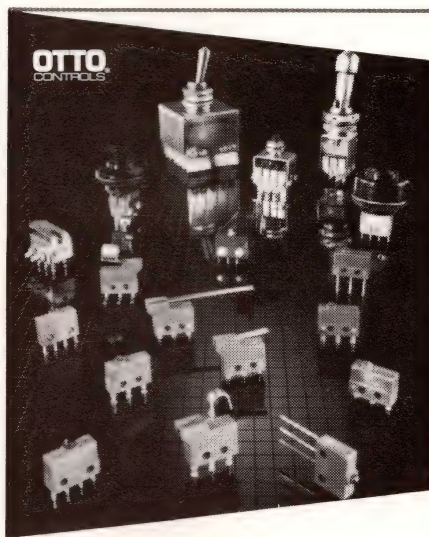
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CIRCLE NO 34

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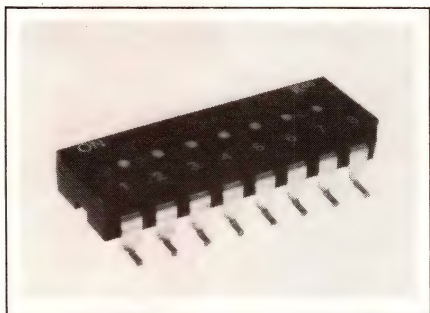
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CIRCLE NO 36

Components



in both gull-wing and J-bend surface-mount configurations. Because the switches have totally flush, sealed tops, they are suitable for use in pick-and-place equipment.

Switch housings are made of Ryton for high-temperature tolerance. Maximum contact resistance is 20 mΩ initially and 80 mΩ at end of life. The contacts switch 100 mA at 20V dc and carry 100 mA at 50V dc. Insulation resistance and dielectric withstanding voltage are 10⁹Ω and 500V dc min, respectively, and capacitance between adjacent switches measures 5 pF max. The

switches have an operating range of -40 to +100°C and a lifetime of 2000 operations. 8-position switch, \$0.65 (10,000).

American Research & Engineering, 1500 Executive Dr, Elgin, IL 60120. Phone (312) 888-7200.

Circle No 698

DISPLAYS

The PD1165 (high-efficiency red) and the 1167 (green) are modular 8×8 dot-matrix LED displays suited for flat-panel graphic applications. They feature built-in CMOS control circuitry, which includes LED drivers, multiplexers, RAM, and display attributes. With a 1.1-in. character height, they are readable from distances ranging to 35 ft.

Both displays are user-programmable so you can set dot patterns to correspond to any graphic representation within the LED matrix.

User-friendly programmable attributes include eight levels of blanking, blinking capability, and blanking, clear, and lamp tests. The displays accommodate a variety of alphabets, including English, Roman, Japanese, Chinese, and Cyrillic. They are X-Y stackable and easily cascable with built-in synchronizing circuitry to form any size display panel. Supply-voltage requirements range from 4.5 to 6V dc, and the operating range spans -20 to +70°C. PD1165, \$27.60; PD1167, \$30.35 (100).

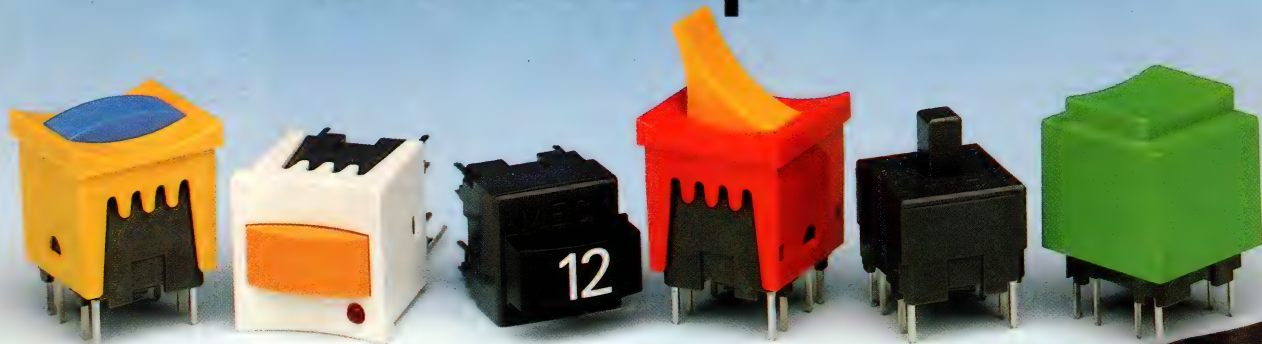
Siemens Components Inc, Optoelectronics Div, 19000 Homestead Rd, Cupertino, CA 95014. Phone (408) 725-3548.

Circle No 699

PLASMA DISPLAY

The FPF-8050-HFUG dot-matrix, ac-memory display uses 64-bit LSI drivers, which reduce power con-

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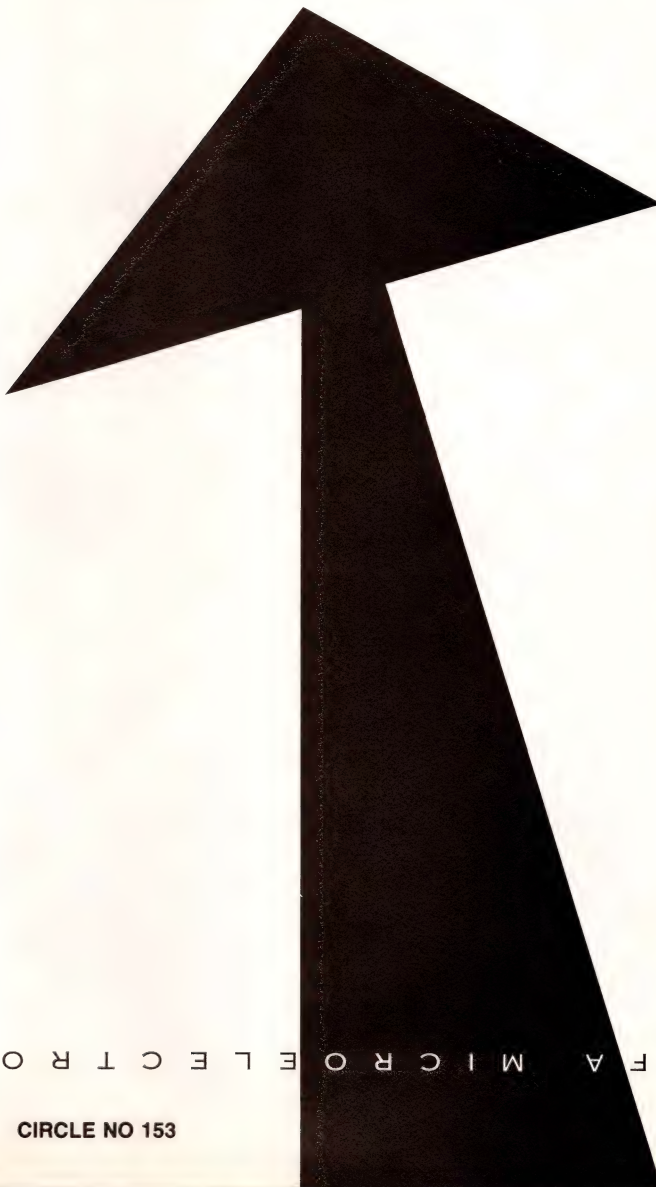
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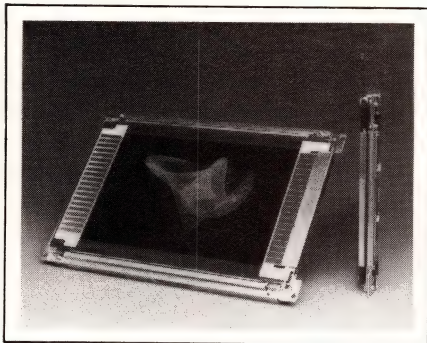
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CIRCLE NO 152

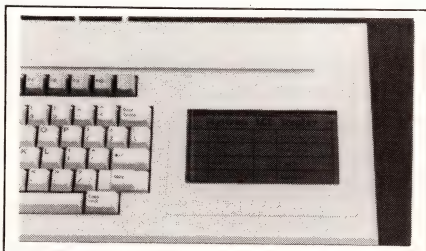
Components



sumption at 100% illumination to only 35W. Drive electronics interface easily with CRT controllers, and special-application controllers are also available. When fully assembled with drive circuitry mounted directly to the back of the panel, the unit is 1.063 in. thick. The 8.3×5.2-in. viewing area is arranged as 640 columns×400 rows. The display features 44-fL character brightness, a 120° viewing angle, a 20:1 contrast ratio, and a 50,000-hour MTBF. The flicker-free panel has an orange-on-black display for enhanced character readability. \$945.

Fujitsu Component of America Inc., 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-1700. TWX 910-338-0190.

Circle No 700



KEYBOARD

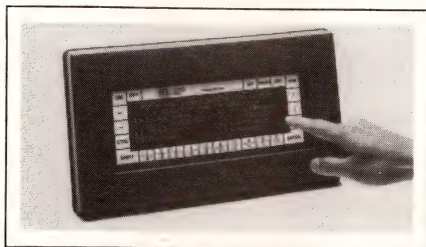
The KD220 keyboard combines a touchscreen with interactive features. The keyboard includes a 5×2.75-in. clear-membrane touchscreen, which you can use as a cursor, a programmable keypad, or both. You can incorporate macrokey words, short and long strings, or icons into programmed screen options for high input flexibility.

The 128 modifiable key positions specify a key travel of 0.15 in. Key-

switch force is 2 oz nominal, and keys are available with either tactile or linear feel. The keyboards are impervious to moisture and dust debris and feature a MTBF of 10⁹ actuations. The serial output is TTL compatible. A 1-year warranty is standard. From \$395.

Xcel Corp., 3100 New York Dr, Pasadena, CA 91107. Phone (818) 791-5600.

Circle No 701



DISPLAY MODULE

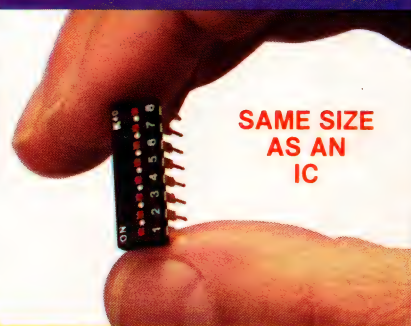
The 4283-01 vacuum-fluorescent display module integrates a 6-line×40-character display with an infrared touchscreen. The module uses no overlays, features 969 active switch locations, and is immune to false triggering by ambient light—even direct sunlight. Each of the display's 240 5×7 dot-matrix characters is 5 mm high. The blue-green color provides comfortable viewing, and three software-controlled brightness levels are available (ranging to 185 fL max). Colored filters are available to fit different applications.

The module has the ability to store and retrieve user-programmable canned messages; 8k bytes of CMOS RAM can store 127 canned messages. Onboard battery backup retains the messages even after power is lost. The module operates from a 5V supply. An onboard μ P controls display and touch-input operations, a self-diagnostic test program, and the serial data interface with the host computer. From \$800 (100).

IEE Inc., 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311.

Circle No 702

WORLD'S SMALLEST DIP SWITCH



BETTER HEAT CONVECTION.

OLD DIP SWITCH



NEW DIP SWITCH



NO MORE HAND LABOR.



YOU CAN USE AUTOMATIC INSERTION EQUIPMENT!

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AVAILABLE IN 2, 3, 4, 5, 6, 7 & 8 POSITIONS

FREE SAMPLE!

WITH STAPLED BUSINESS
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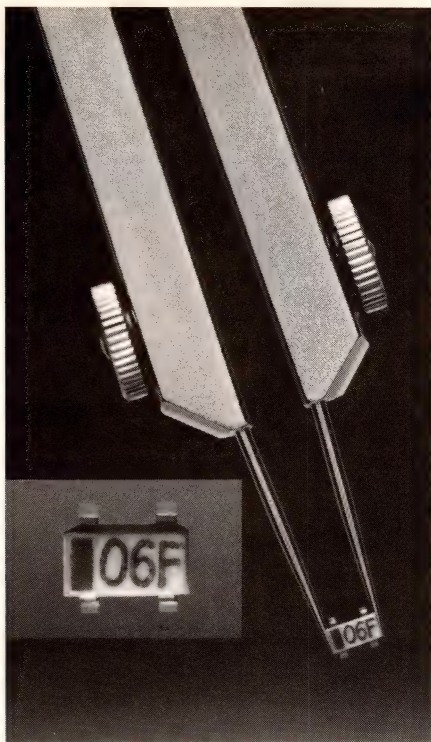
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312-898-7245



America can do it better!

Components



Big news for surface mount designers.

Our P2824 Optoisolator/Photocoupler is ideal for tight spaces, specs and budgets. This subminiature molded component is engineered for easy surface mounting in many OEM designs.

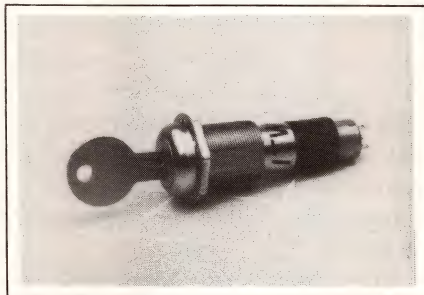
Boasting a 1500 Vrms isolation voltage despite its compact size, the P2824 is already used in many Japanese VCR's, CD players, cassette recorders and computers. Manufactured by Hamamatsu, a world leader in photonic devices and detectors, this space-saving component is also a budget-saver.

For complete information, call 1-800-524-0504
1-201-231-0960 in New Jersey

HAMAMATSU

HAMAMATSU CORPORATION
360 FOOTHILL ROAD
P.O. BOX 6910
BRIDGEWATER, NJ 08807
PHONE: 201/231-0960
International Offices in
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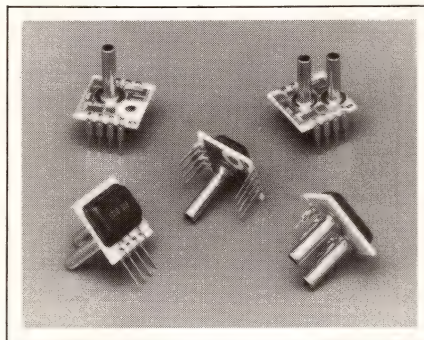


KEYLOCK SWITCHES

F036 Series antistatic rotary keylock switches feature 20-kV dc protection. The keylock/switch combination is available with 30, 36, 45, 60, and 90° angle of throw with various key pulls. Switches are available with one to six poles, and momentary switch configurations are available. Standard devices have silver contacts with a 150-mA rating at 115V ac resistive and 200 mA at 28V dc resistive. Gold contacts are available for low-level switching. You have a choice of 650 key combinations. You can also opt to have the same key combination for all switches. \$12.50 (OEM qty). Delivery, 12 weeks ARO.

ITW Switches, 6615 W Irving Park Rd, Chicago, IL 60634. Phone (312) 282-4040.

Circle No 703



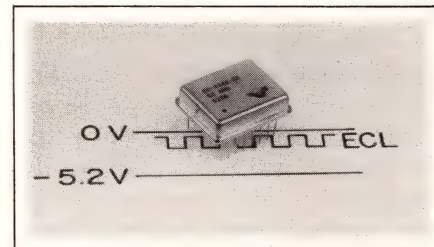
PRESSURE SENSORS

The HIT Series, a family of solid-state, piezoresistive pressure sensors, is packaged in single-in-line and dual-in-line configurations. The sensors provide a 100-mV output span and spec an accuracy of $\pm 0.1\%$. Maximum pressure capabilities range from 2 to 100 psi for gauge and differential models to 5 to 30 psi

for absolute models. Some models measure corrosive liquids as well as moist air, and one model lets you measure absolute pressure without exposing the sensor die circuitry to the media. Two performance grades are available. Other options include low or high impedance, integral temperature compensation, span normalization, and interchangeability. \$10 to \$26 (500).

IC Sensors Inc, 1701 McCarthy Blvd, Milpitas, CA 95035. Phone (408) 946-6693.

Circle No 704



OSCILLATORS

CO-434V Series voltage-controlled crystal oscillators are designed specifically for phase-locking applications. The hybrid oscillators provide ECL-compatible outputs at any specified center frequency from 8 to 200 MHz. Deviation over the 0 to 5V control voltage range varies from ± 30 to ± 200 ppm. This deviation is adequate to permit locking onto the specified center frequency over the operating environment for 10 to 20 years without adjustment. The oscillators are available in two operating ranges: 0 to 50°C and -55 to +85°C. Aging-rate specs are 3 to 5 ppm for the first year and then 2 ppm per year thereafter. Supply requirements are -5.2V at 30 to 60 mA. \$222. Delivery, 10 weeks ARO.

Vectron Laboratories Inc, 166 Glover Ave, Norwalk, CT 06850. Phone (203) 853-4433. TWX 710-468-3796.

Circle No 705

OSCILLATORS

MSO Series surface-mountable crystal-clock oscillators measure

Precision High Voltage Resistors and Resistor Networks from CADDOCK for high performance, high voltage systems.

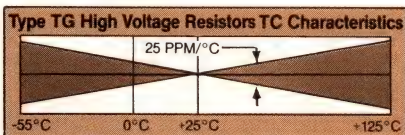


Type TG Low TC Precision High Voltage Resistors with a TC of 25 PPM/°C from -55°C to +125°C and resistance values to 1,000 Meg.

Constructed with Caddock's Tetrinox® resistance films to achieve exceptional temperature and loadlife stability, the Type TG high voltage resistors are ideal for the precision circuitry of TWT power supplies, electron microscopes, X-ray systems, high resolution CRT displays and geophysical instruments.

The Type TG resistors deliver this outstanding combination of performance specifications:

- Temperature Coefficient of 25 PPM/°C from -55°C to +125°C.



- Resistance range from 1 Meg. to 1000 Meg.
- Resistance Tolerances from 1.0% to 0.1%.
- Loadlife Stability of 0.25% per 1000 hours.
- Voltage ratings up to 48,000 volts.
- Max. Continuous Operating Temp. of +225°C.
- Exclusive Non-Inductive Performance.

plus - Matched Resistor Sets with Low Ratio Temperature Coefficient Tracking Performance.

The Type TG resistors can be used in combination with the low TC of Caddock's Type TK Low TC Precision Radial-Lead Resistors to achieve 30 PPM/°C Ratio TC without special matching.

With special matching, a Ratio TC of 10 PPM/°C can be achieved.

- For Type TG data, circle Number 101.

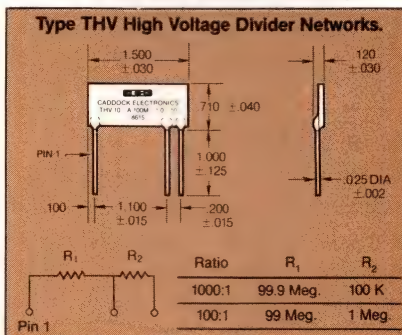


Type THV Thin-Profile 10 KVDC Precision Resistor Voltage Divider Networks with Ratio TCs to 10 PPM/°C from -55°C to +125°C.

Caddock's advanced high voltage resistor technology combines our high stability Tetrinox® resistance films with laser-generated V-Notch Geometry (Pat. Pend.) to produce this compact high voltage divider network.

The performance of these high stability networks includes these special features:

- Standard Input Resistance of 100 Megohm with custom resistances available.
- Standard Voltage Division Ratios of 1,000:1 or 100:1 with custom ratios available.
- Ratio Tolerances of 0.25%, 0.5%, 1.0% or 2.0% at 10 KVDC.
- Ratio Temperature Coefficients of either 10 PPM/°C or 25 PPM/°C from -55°C to +125°C.
- Non-Inductive Performance.
- Thermal coupling between the resistors in this single-substrate network provides excellent Ratio Temperature Coefficient stability.



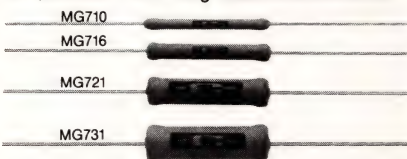
- The thin-profile and 1.5 inch body length provides for easy packaging in space-sensitive designs.

- For Type THV data, circle Number 102.



Type MG Precision High Voltage Resistors with extended resistance range to 10,000 Megohm and a TC of 80 PPM/°C.

For greater design flexibility, Caddock's 'family' of Type MG resistors has been expanded with additional models and now includes 23 models that permit designers to select the optimum resistor size, power rating and voltage rating for each application, as illustrated by the four models of 4,000 volt, 1-inch long resistors shown here:



The Type MG high voltage, high stability resistors include all of these performance specifications:

- Standard Temperature Coefficient of 80 PPM/°C.
- Resistance values to 10,000 Megohm.
- Resistance Tolerances from 1.0% to 0.1%.
- Loadlife Stability better than 0.8% per 1000 hours.
- Voltage ratings up to 48,000 volts.
- Max. Continuous Operating Temp. of +225°C.
- Exclusive Non-Inductive Performance.

Most models of these high voltage resistors are manufactured with Caddock's Exclusive Non-Inductive Design for improved performance in high frequency, pulse and wide-band circuits.



- For Type MG data, circle Number 103.

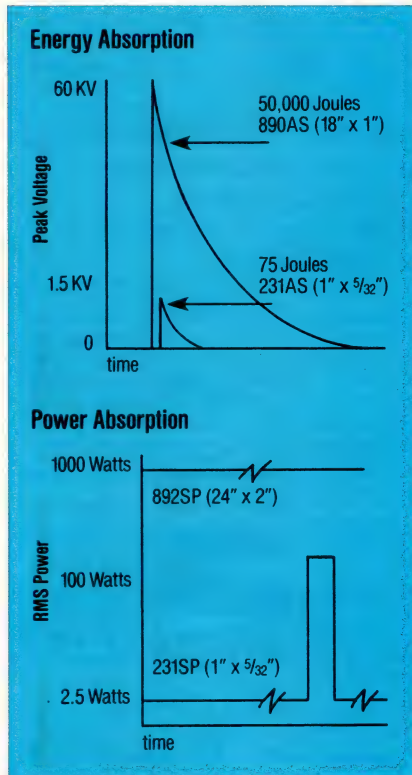
Caddock's new 28-page General Catalog describes over 200 models of standard and custom precision and ultra-precision resistors and resistor networks. For your personal copy, call or write our main offices at - Caddock Electronics, Inc., 1717 Chicago Avenue, Riverside, California 92507 • Phone (714) 788-1700 • TWX: 910-332-6108

CADDOCK

HIGH PERFORMANCE FILM RESISTORS
CIRCLE NO 104

Carborundum® noninductive ceramic power resistors solve tough problems.

We make three types of noninductive ceramic resistors that can solve tough resistance problems, save money and space.



Regardless of the pulse shape, we have the resistor. Our Type SP handles large amounts of power from 60 cycles through VHF. Type AS can absorb huge amounts of energy in millisecond pulses. Type A solves high resistance problems in high voltage situations.

For more information on ceramic power resistors and our broad line of thermistors and varistors, call or write today.

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COMPONENTS

CIRCLE NO 40

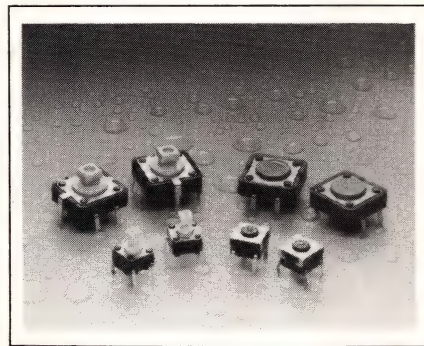
Components

only 0.56×0.36 in. and have a mounted height of 0.16 in. They are available over a frequency range of 1.5 to 35 MHz and have a frequency stability of ±0.01% from 0 to 70°C.

The oscillators come in sealed ceramic packages with either a J- or C-lead configuration; the package is compatible with standard pick-and-place equipment. The devices are available in tape and reel or in anti-static tubes and are vapor-phase/wave-solder reflowable. Features include a 5000g shock rating and tight symmetry (55/45%). An enable/disable feature is optional. The oscillators are hermetically sealed and assembled automatically in a class 100 clean room. From \$3.50 (1000). Delivery, 12 weeks ARO.

Motorola Inc, Components Div,
2553 N Edgington St, Franklin
Park, IL 60131. Phone (312) 451-
1000. TWX 910-255-4619.

Circle No 706



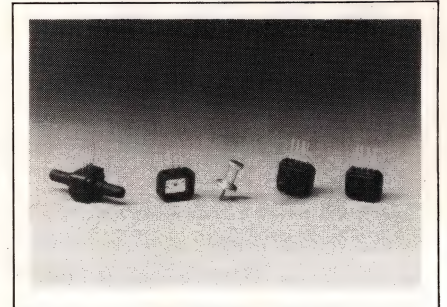
KEYSWITCH

Model B3W is a mechanical key-switch fully sealed to withstand immersion-cleaning processes. It has a switching capacity of 50 mA at 24V dc. The switch is available with various actuation forces. Standard force equals 160g for 6-mm models and 200g for 12-mm models. High-force versions specify 230 and 350g for 6- and 12-mm units, respectively. A snap-action contact mechanism provides short key stroking with a sharp click. Some models offer a ground terminal to guard against static. The minimum permissible load is 1 mA at 5V dc; bounce time is 5 msec; and contact and insulation

resistance are 100 mΩ max and 10⁸Ω, respectively. \$0.24 (500).

**Omron Electronics Inc, 1 E
Commerce Dr, Schaumburg, IL
60173. Phone (800) 626-6766.**

Circle No 707



PRESSURE SENSORS

Devices in Series 14PC, assembled with an elastomer O-ring seal, are available in gauge and differential versions and 5-, 15-, and 30-psi models. The TAB procedure used in assembly provides bond strengths that are 10 times stronger than conventional wire bonds. In addition, only eight interconnections are required. The sensing resistors are connected in a 4-active-element bridge.

An elastomer seal surrounds the pressure-sensitive diaphragm. The diaphragm is exposed to pressure media applied through the ports, which are ultrasonically welded in place. You can change the seal material to fit particular media requirements. \$6.40 (5000).

**Micro Switch, 11 W Spring St,
Freeport, IL 61032. Phone (815)
235-5731.**

Circle No 708

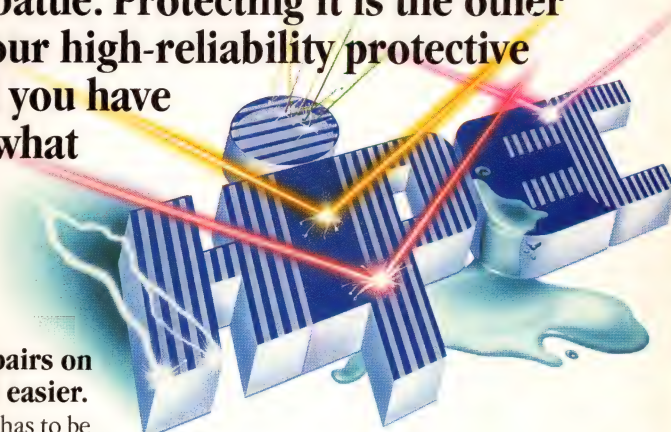
BILEVEL LEDs

Series 552 (T-1¾ package size) and 553 (T-1 package) bilevel LEDs stack the indicators vertically, rather than horizontally, so the LEDs take up 50% less space. The indicators are housed in a black casing for enhanced color contrast. You have a choice of standard-efficiency, high-efficiency, and super-bright LEDs, as well as super-efficiency LEDs

A Design Digest of Electronic Reliability



Designing a high-performance electronic product is only half the battle. Protecting it is the other half. Demand our high-reliability protective materials and you have won. Here is what we mean:



New thermally-conductive elastomer **conductive to many uses.**

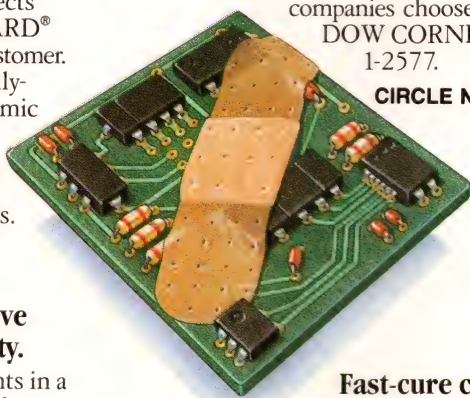
For thermal dissipation that protects performance, choose new SYLGARD® Q3-6605 thermally-conductive elastomer. It is especially useful as a thermally-conductive adhesive to bond ceramic hybrid circuit packages to heat sinks. Other uses include bonding or potting power supplies, coils, heavy-duty relays, and similar units. Primerless, too.

CIRCLE NO 76

Protective silicone gels relieve stress and improve reliability.

When you encapsulate components in a silicone gel, you protect them against hostile environments, temperatures as low as -80°C and more. DOW CORNING® silicone gels also cushion components against stress and vibration. We offer a broad choice of one component and two component materials, for room temperature and heat cure processes.

CIRCLE NO 77



Coating makes repairs on PC boards easier.

A PC board coating simply has to be reliable. And with DOW CORNING® 1-2577 conformal coating you get more: easy repairability when components need replacing. Add superior protection in extreme environments, versatile processing with dipping or spraying, and you have all the reasons major automotive and military electronics companies choose

DOW CORNING
1-2577.

CIRCLE NO 115

Fast-cure coating for fiber optics.

OPTIGARD® optical fiber coating UV-cures in just 0.3 seconds—5 to 20 times faster than thermal-curing coatings. And it protects against moisture and “micro-bends” better than acrylate coatings. It’s part of the OPTIGARD family which includes fiber optics grade SiCl₄ core and cladding and OPTIGARD cable filler.

CIRCLE NO 116

Life insurance for semiconductors.

Stress. Moisture. Ion contamination. Voltage linkage. Alpha particles. All are killers of your devices, robbers of reliability. Now you have a defense against them. HIPEC® coatings protect semiconductors and hybrids through a wide range of temperatures and environments. They’re available in a variety of forms from gel to firm elastomer and resins. And HIPEC coatings are easier to process than other high-performance materials.

CIRCLE NO 154

There’s more.

There’s also our unique team of experts whose only mission is to develop and customize coatings, adhesives, dispersions, sealants, and components specifically for you. Supported by dedicated research and manufacturing facilities, we will help you meet tomorrow’s challenges today. Ask about our Specialty Elastomers, Group.

Write Department 7013, Midland, MI 48686-0994.

CIRCLE NO 155

DOW CORNING®

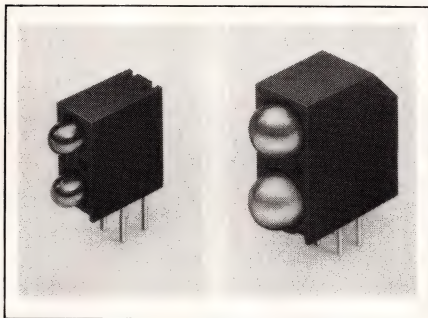


FINALLY, A SNAP- ACTION THERMOSTAT IN A DIP PACKAGE.

New Airpax Series 6600 thermostats are specially designed to be compatible with all automated production techniques common to PC board manufacturing. They can be installed with DIP auto-insertion equipment. They are sealed to withstand wave soldering and washing operations. And they provide both sensing and switching in a single space-saving device. Best of all, the Series 6600 combines production expediency with proven accuracy and reliability. Bimetallic snap-acting thermostats, the Series 6600 feature fast, positive response and excellent repeatability with 1 amp switching capability over a temperature range of 40°C (104°F) to 120°C (248°F). To ensure performance, the temperature is factory pre-set, and cannot be altered in the field. Add automated thermostat installation to your PC board production line. Call us today for configuration availability and further details. Airpax Corporation, Frederick Division, Husky Park, Frederick, MD 21701. (301) 663-5141. A North American Philips Company.

AIRPAX®
FREDERICK DIVISION

Components



that produce full light output at only 2-mA forward current. Integral resistor lamps, which operate at 5 and 12V, are also available. Both series are available in red, green, or yellow. Bicolor units, containing red and green chips in one package, are also available. \$0.62 (1000).

Dialight Corp, 1913 Atlantic Ave, Manasquan, NJ 08736. Phone (201) 223-9400.

Circle No 709

HUMIDITY SENSOR

The RH-8 sensor and the SCMC signal-conditioning microcircuits are for constructing humidity transmitters. The RH-8 is a bulk-resistance-polymer relative-humidity (RH) sensor. The bulk-polymer design minimizes accuracy degradation due to contamination and keeps long-term drift below 1% per year.

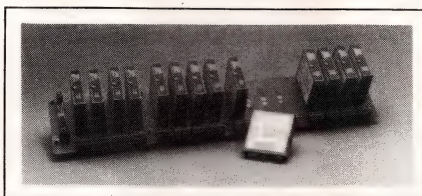
Onboard temperature compensation provides accurate humidity outputs from 0 to 50°C over a humidity range of 0 to 95%. The SCMC-V provides a linearized 0 to 1V dc output, and the SCMC-I provides a linearized, 2-wire, 4- to 20-mA output. In a simple circuit, the combination of the RH-8 and an SCMC produces an accuracy of $\pm 3\%$ RH. RH-8, less than \$20; SCMC-V, \$15; SCMC-I, \$18 (200).

General Eastern Instruments, 50 Hunt St, Watertown, MA 02172. Phone (800) 225-3208; in MA, (617) 923-2386.

Circle No 710

SIGNAL CONDITIONERS

The input modules in the 5B Series of signal conditioners accept signals



from thermocouples and RTDs as well as millivolt, volt, and 4- to 20-mA signals; the output module provides a 0- to 20-mA or 4- to

20-mA signal. The modules are laser-trimmed to produce $\pm 0.05\%$ accuracy. They have no potentiometers and are completely sealed.

The modules are designed for electrically noisy environments. They provide $\pm 1500V$ isolation, 160-dB common-mode rejection, 60-dB normal-mode rejection, 240V input protection, and they meet



**NO OTHER
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CAN HOLD
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LSI electroluminescent (EL) lamps offer the designer a surface illumination alternative far superior to incandescent or other conventional light sources. And, whereas other makes of EL lamps may offer some of our product features, comparative tests prove that for long life, brightness, uniform light diffusion, color stability, resistance to moisture, heat, vibration and shock, no other EL lamps can match ours.

Thin, flexible and lightweight—Many shapes, sizes and colors

These rugged, solid-state EL lamps provide cool, uniform light across the entire lamp surface, eliminating the need for sockets, bulbs, diffusers and reflectors. Power consumption is small due to low current demand. A thin profile (.032") permits high density packaging; and with IC-style leads available, lamps are compatible with PCBs. Although stocked in rectangular shapes for immediate delivery, we can design EL lamps in a variety of custom shapes and sizes including complex forms with

multiple holes and cutouts. Available with pressure-sensitive adhesive on front or rear surfaces.



If you'd like a copy of our brochure, or have questions regarding EL applications, just call, write or TWX the LSI Marketing Department.

**Luminescent
Systems
Inc.**

Setting the Standard

Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766



Dialight Components. For a complete selection that builds on quality.

Indicator lights, switches, and optoelectronics. Literally millions of Dialight components to choose from. All constructed for the kind of reliability that will do justice to your finished product.

Take Dialight LED circuit board indicators, for example. They're 100% pretested, and feature an easy to mount modular design for reliable, labor-saving board assembly.

Or Dialight readout displays. Complete assemblies ready for instant panel-mounting to save time and money.

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Then there's Dialight indicator lights. Incandescent, LED or neon light sources available in a wide range of sizes and configurations. They'll meet just about

any application requirement including military specs. In fact, we've developed over a million different indicator light designs to become the world's largest manufacturer.

Call us today at (201) 223-9400, or write Dialight Corporation, 1913 Atlantic Ave., Manasquan, NJ 08736. If you can't find what you need in our free catalogs, we'll design it for you. So whatever it is you're building, you can build on quality. With Dialight components.

DIALIGHT CORPORATION

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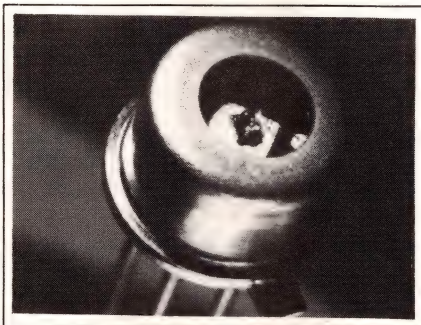
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Components

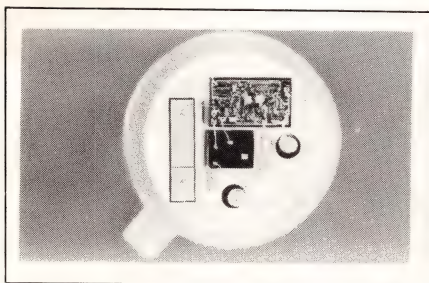
IEEE-STD-472 to withstand 2500V transients. Chopper-based amplification ensures $\pm 0.0025\%/^{\circ}\text{C}$ max drift, and typical nonlinearity equals $\pm 0.01\%$. All units provide linearization when required. They operate from 5V over a -25 to $+85^{\circ}\text{C}$ range. \$105 (100).

Analog Devices Inc, 70 Shawmut Rd, Canton, MA 02021. Phone (800) 245-3900; in MA, (617) 461-3643.

Circle No 713



coupling efficiency. The package fits directly into standard fiber-optic connector systems. LED output wavelength equals 805 nm typ. The minimum launch power (at $I_F=100$ mA for a 100- μm -core fiber) is guaranteed at 60 μW for the MFOE1100, 120 μW for the MFOE1101, and 180 μW for the MFOE1102. The emitters are compatible with the compa-



OPTICAL MODULES

The 10M-bit HFE4010 transmitter and the 5M-bit HFD3000 receiver have all the necessary driver circuitry integrated into the same package and thus eliminate the need for external peripheral circuitry.

The receiver has a sensitivity of less than 1 μW , allowing operation over several kilometers. It contains a photodiode, a preamplifier, gain stages, a TTL output stage, and a regulator. The transmitter includes a GaAlAs LED (with a microlens) and a TTL-compatible driver circuit. The operating range is -55 to $+125^{\circ}\text{C}$; the parts operate from a 5V supply. Both devices are housed in TO-46 metal packages that can be mounted in a variety of receptacles or active connectors. HFE4010, \$22; HFD3000, \$19.47 (100).

Honeywell Optoelectronics Div, 830 E Arapaho Rd, Richardson, TX 75081. Phone (214) 234-4271.

Circle No 714

OPTICAL SOURCES

MFOE1100 Series LEDs use an AlGaAs process to enhance output power and a built-in lens to increase

WE CAN MAKE ANY LCD EASY TO READ.

Our thin, flexible electroluminescent lamps dramatically improve LCD readout by providing higher contrast and better visibility. A thin profile (.032") allows high density packaging, and pressure-sensitive adhesive can be supplied on front or rear surfaces for rapid assembly.

Uniform, cool light source in many shapes, sizes and colors

Our backlighting ELs emit even illumination across the entire lamp surface. They also eliminate the need for sockets, bulbs, diffusers or reflectors. Lamps are usually supplied in rectangular shapes, but we can create many custom shapes and sizes including complex forms with multiple holes and cutouts. With IC-style leads, lamps are compatible with PCB assembly. Eight standard colors are available and custom colors can be created.

If you'd like more information relating to LCD applications, just call, write or TWX the LSI Marketing Department.



Luminescent Systems Inc.

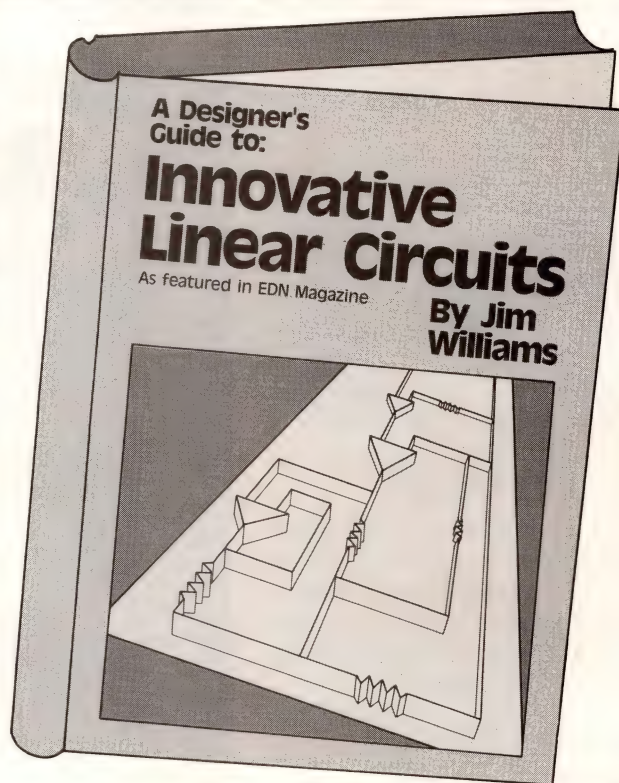
Setting the Standard

Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

ANALOG IS ALIVE AND WELL IN: A Designer's Guide to Innovative Linear Circuits

As exciting as digital technology is, you still need analog circuitry to operate on signals from real-world sources. Now, EDN is offering a wealth of analog design information in *A Designer's Guide to Innovative Linear Circuits*.

This 186-page collection of articles was developed by Jim Williams, one of America's foremost linear-circuit designers. It includes practical and efficient ways to use op amps, comparators, data converters, and other analog ICs, and discusses the theories behind all the design techniques presented.



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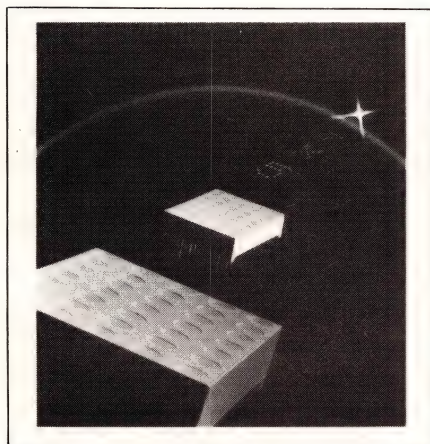
CITY _____ STATE _____ ZIP _____

Components

ny's line of fiber-optic detectors. MFOE1100, \$11.25; MFOE1101, \$15.96; MFOE1102, \$20.63 (100). Delivery, stock to six weeks ARO.

Motorola Semiconductor Products Inc., Box 52073, Phoenix, AZ 85036. Phone (602) 244-3818.

Circle No 711



LEDs

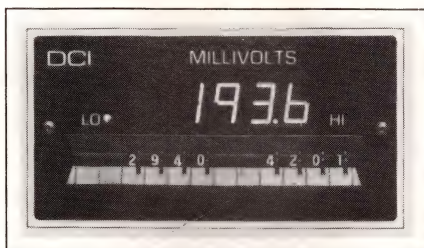
These red, 5×7 dot-matrix alphanumeric LED displays, the HDSP-470X and HDSP-440X, have character heights of 0.68 and 1.04 in., respectively. Viewing ranges are 18m for the -470X and 12m for the -440X. Housed in DIPs, both displays are available in either common-row anode or common-row cathode versions. You can stack the modules to create an X-Y grid. They're suitable for graphics-panel applications because they are categorized according to luminous intensity, so you can choose modules that ensure a uniform appearance. -440X, \$7.18; -470X Series, \$6.65 (101).

Hewlett-Packard Co., 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 712

CONTROLLER

By varying the reference voltage, you can scale the display of the Series 200B panel-mounted voltmeter controller to read out a voltage in engineering units. It has dual-alarm setpoints and either 4 or 4½



digits of display with polarity. The unit has a front-panel status indica-

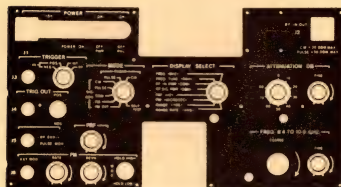
tor to let you know if the parameter being monitored is below, between, or above the alarm setpoints.

Standard input-voltage ranges are 0 to 200 mV and 0 to 10V. Outputs include form-C relay closure for each limit, logic-level outputs for Low, In, and High, and optional optically isolated BCD lines. The display features 0.6-in.,

GIVE US .085" FOR AN ILLUMINATED PANEL NO ONE CAN MATCH.



At only .085" thick, our new fiberglass electroluminescent panels are designed to replace lightplates and traditional metal plates that may not presently be illuminated. Our thin .085" panels weigh 40% less than a typical .220" plexiglass panel, and with an expansion coefficient equal to aluminum, the panels are ideal for surface-mount applications.



LSI electroluminescent panel

As the pioneer developers of EL lamps, as well as the process of encapsulation, we have combined the uniform, cool surface illumination of EL with the strength of fiberglass to create a new standard for panels.

Durability and long life luminescence

LSI EL lamps eliminate the need for sockets, bulbs, diffusers or reflectors, and add no heat to the assembly. This, together with their long life and availability in many colors, make them the intelligent choice for panel illumination — far superior to LEDs or incandescent bulbs. We create panels (including standard .220" plexiglass) in almost any shape and size, as well as complex designs with multiple holes and cutouts. Lamps can be filtered to comply to ANVIS or other military specifications, or to your design requirements.

If you'd like a copy of our brochure, or have questions regarding panel applications, just call, write or TWX the LSI Marketing Department.

Luminescent Systems Inc.
Setting the Standard

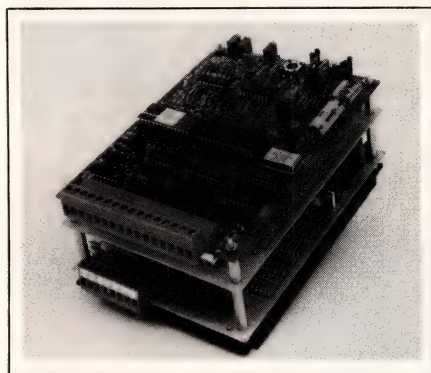
Tel. (603) 448-3444 TWX 710-366-0607
Etna Rd., Lebanon, NH 03766

Components

high-efficiency-red LEDs with sculptured corners for easy reading at 30 ft. Designed for industrial environments, the unit has a heavy-duty aluminum case, UL-listed pc-board materials, and gold-plated I/O contacts. From \$299. Delivery, four to six weeks ARO.

DCI Inc, Box 215, Olathe, KS 66061. Phone (913) 782-5672.

Circle No 716



MOTOR CONTROLLER

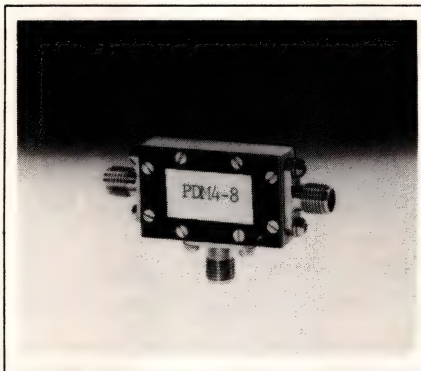
Using incremental-encoder feedback, the PIC-850 Series controller/driver controls both the position and velocity of a dc motor. It sends motion commands to the controller in the form of pulses; a separate direction line controls the direction of motion. By varying the input-pulse frequency, the unit can specify the motor velocity and produce complex velocity profiles. It can control motors with ratings as high as 3 hp. Other features include resonance-free operation at speeds from 0 to 600,000 pulses/sec, tolerance of position errors ranging to 32,767 counts, and an onboard 13-bit D/A converter. \$995 to \$1500.

Galil Motion Control, 1928-A Old Middlefield Way, Mountain View, CA 94043. Phone (415) 964-6494. TLX 171409.

Circle No 715

PHASE DETECTOR

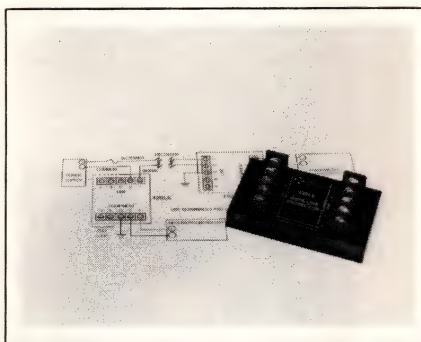
The PDM4-8 double-balanced phase detector provides a dc output voltage proportional to the phase and amplitude differences of the RF in-



puts. Typical specifications are a 4- to 8-GHz frequency range, an 8-dB nominal conversion loss, and a -1-dB output response of dc to 300 MHz. The output voltage with 0° and 180° inputs into a 50Ω load equals ± 0.6 , ± 60 , and ± 110 mV for both RF input signals of -10, 0, and +3 dBm, respectively. With a 1-kΩ load, respective outputs measure ± 28 , ± 150 , and ± 180 mV. Removable connectors allow you to use the device in drop-in applications. The device operates over -30 to +70°C. \$850. Delivery, 150 days ARO.

RHG Electronics Laboratory Inc, 161 E Industry Ct, Deer Park, NY 11729. Phone (516) 242-1100. TWX 510-227-6083.

Circle No 717



SUPPRESSORS

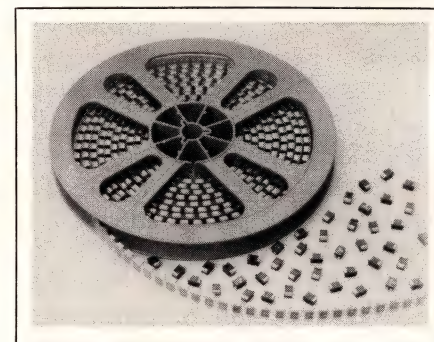
The 420L transient voltage suppressors are available in two types. Each has two pairs of circuits with line-to-line as well as line-to-ground protection. Each type includes models with maximum operating line voltages of ± 28 , ± 35 , and ± 60 V, and maximum clamping voltages of 40, 60, and 85V, respectively.

The 420LE is suitable when you

need to protect only a few lines. It requires no external components and can protect two loops. Electrical connections are via screw terminals. For a larger number of lines, the 420LB pc-board version is more suitable. It inserts into a 15-pin edge connector and can protect as many as 16 loops. All devices feature a short-circuit failure mode to provide maximum protection. They have automatic reset and permanent 2-stage protection. Maximum standby current equals 5 μ A. 420LE, from \$60; 420LB, from \$45 (100).

General Semiconductor Industries Inc, 2001 W Tenth Pl, Tempe, AZ 85281. Phone (602) 968-3101.

Circle No 722



CHIP CAPACITORS

Designed for surface-mount applications, Type 293D molded-case, solid-electrolytic Tantalex chip capacitors conform to IEC QC300801/001, the EIA industry specification for devices having standard capacitance values. Four package sizes are available. Capacitance values span a 0.01- to 100- μ F range. Operation spans -55 to +85°C with no derating (to +125°C with derating). The capacitors come taped on 8- or 12-mm reels, per EIA 481A, for use with automatic-placement equipment. 35V, $\pm 20\%$ -tolerance 1- μ F unit, \$0.21 (1000). Delivery, 8 to 12 weeks ARO.

Sprague Electric Co, Box 9102, Mansfield, MA 02048. Phone (603) 224-1961.

Circle No 718

SINGLE CHIP DELTA* CODECS

- Time Domain Scramblers • Digital Cordless Telephone
- Digital Speech Communications • Voice Storage
- Digital Delay Lines • Speech Analysis
- Multiplexers • General Purpose

*Full Duplex CVSD Codec

Programmable Sampling Clocks

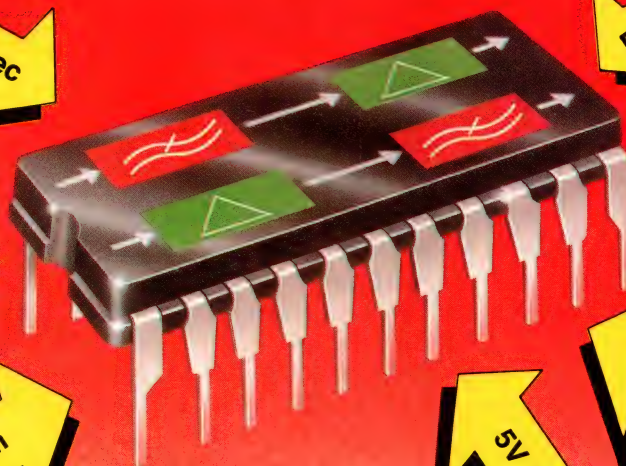
Forced Idle Facility

Powersave Facility

3 or 4-Bit Algorithm

5V CMOS

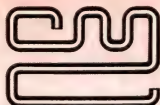
On-Chip Input/Output Filters



FX609J

Also available in surface-mount packages.

FX709 Single Chip Voice Store and Forward Delta Codec
— includes 8-bit I/O port, Power Assessment circuitry and fully programmable circuit elements. Also available; Eurocom Military Communications Delta Codec.



Consumer Microcircuits Limited

1 Wheaton Road, Witham, Essex CM8 3TD England. Telephone: (0376) 513833
Telex: 99382 CMICRO G Telefax: (0376) 518247

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CIRCLE NO 118

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Telex: 78527113 ARTISTEX

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Globotronic Ges.mbh & Co. KG
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Telex: 111618 GLOBO A

GERMANY
Ginsbury Electronic GmbH
Tel: (089) 429161
Telex: 529818 GINSB D

HUNGARY
Datentechnik Ges.mbh & Co
KG
Tel: (0222) 654263/64
Telex: 13109 DATEG A

JAPAN
Cornes & Co. Ltd
Tel: (03) 272 5771
Tel: (06) 532 1012/532 1013
Telex: (Via Cornes London)
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S.A. General De Importaciones
Electronicas 'Sagitron'
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Telex: 43819 SGTNE

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Plessey Zimbabwe Pvt. Ltd
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Telex: 907 4280 PLESSZ ZM

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Heijnen N.V.
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Telex: 39047 HEYHAS B

GREECE
Peter Caritato and Associates
Ltd
Tel: (01) 361979
Telex: 216723 ELBR GR

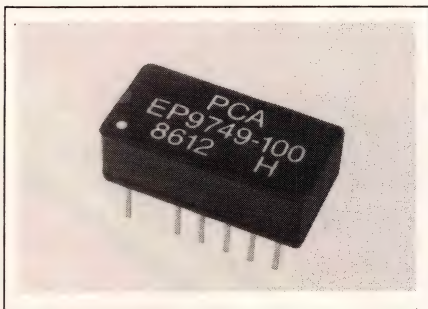
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Ritika Systems Private Ltd
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Telex: 031 61059 ELEC IN

KOREA
S.TEC International
Tel: (2) 784 6800
Telex: K23456

SWEDEN & FINLAND
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Telex: 10038 GESAB S

U.S.A. & Canada
MX-COM Inc.
(A member of the CML
Microsystems Plc group)
Tel: (919) 744 5050
Telex: 5101012852 MXCOM INC
WSL

Components



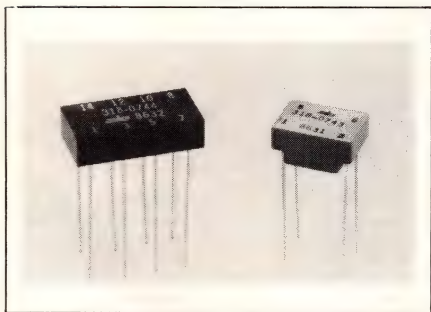
DELAY LINES

EP9749 Series TTL-compatible active delay lines are aimed at MIL-STD-883 applications that require as many as 10 equally spaced delays. Total delay times for the 28 members in the series range from 50 to 1000 nsec, and accuracy is $\pm 5\%$ or 2 nsec, whichever is greater.

These delay lines are specifically designed for severe-environment applications that require high delay stability, fast rise time, and no jitter. The delay-line input and the 10 output taps are buffered by a Schottky TTL converter. Maximum output rise time is 4 nsec for lines with total delay times of 500 nsec or less, and 5 nsec for models with greater than 500-nsec delays. The 14-pin DIP measures $0.400 \times 0.285 \times 0.800$ in. Operating range spans -55 to $+125^\circ\text{C}$. The EP9749-100, a 100-nsec delay line, costs \$9 (1000). Delivery, stock to six weeks ARO.

PCA Electronics Inc., 16799 Schoenborn St, Sepulveda, CA 91343. Phone (818) 892-0761.

Circle No 720



TRANSFORMERS

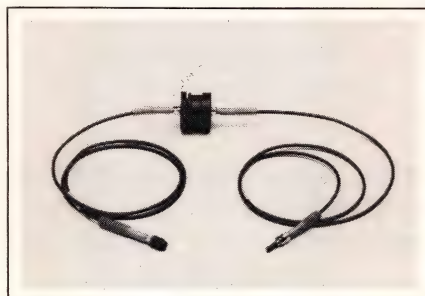
These StarLAN local-area network transformers, the 8631 and 8632, are suitable for coupling Manches-

ter-encoded data at 1-MHz data rates to a 92Ω twisted-pair bus conforming to the IEEE 802.3 1BASE5 standard for LANs. Available in single- and dual-transformer versions, the devices handle loads of approximately 100Ω over a range of 250 kHz to 2 MHz.

In the transmitting mode, an RS-485 driver, which has pulse shaping to reduce the rise and fall times, drives the transformer so that the transmitted pulse approximates a sine wave. In the receive circuit, the limited bandwidth of the transformer helps reduce high-frequency noise. The devices are unaffected by interference from adjacent transformers or other sources. Dual and single versions, \$5.85 and \$3.25 (1000), respectively.

AIE Magnetics, 701 Murfreesboro Rd, Nashville, TN 37210. Phone (615) 244-9024.

Circle No 719



ATTENUATOR

The A438 variable fiber-optic attenuator is designed for systems that use ST type connectors. You can use the unit to simulate the loss of long cable runs when doing link margin testing. You can also use it to adjust received optical power in short-run systems to prevent receiver saturation. The attenuator uses the gap loss principle to induce loss in the range of 1 to 20 dB. Unlike many variable attenuators, it works equally well with any size fiber and any wavelength source. You simply attach the ST connectors to either side of the attenuator and rotate the barrel to adjust the loss. \$175.

Fotec Inc, Box 246, Boston, MA

02129. Phone (617) 241-7810. TLX 501372.

Circle No 723

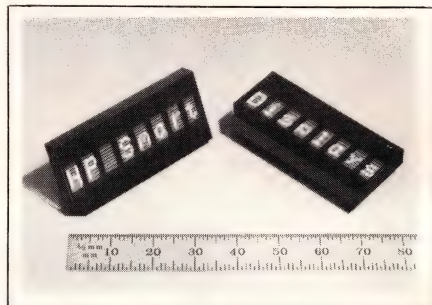
AMPLIFIER

The NE5212 monolithic transimpedance amp amplifies current variations from photosensitive diodes to convert optical signals into electrical signals. It is designed to work in both linear and digital applications over a dc to 100-MHz range and supports various data rates.

The amplifier features a single-ended input and a differential output. Performance specifications include $14\text{-k}\Omega$ differential transresistance and minimized bandwidth degradation caused by photodiode capacitance. The amplifier operates on 5V dc. It's available in 8-pin plastic and ceramic DIPs and surface-mount SO packages. Plastic DIP and SO packages \$2; ceramic DIP, \$2.43 (1000).

Signetics Corp, Box 3409, Sunnyvale, CA 94088. Phone (408) 991-2000.

Circle No 721



DISPLAYS

These intelligent 8-character alphanumeric displays feature a 5×7 dot-matrix font. They come in standard 0.6-in. 28-pin DIPs and are available in two colors: yellow (HDSP-2111) and high-efficiency red (HDSP-2112). An onboard CMOS IC minimizes power consumption and provides the 128 ASCII character set. In addition, 16 user-definable characters allow you to generate foreign characters, special symbols, and logos.

FAT CAT.

NKK has the fattest catalog in the switch jungle. 813,000 different devices. 34 distinct families. 336 pages.

But the NKK Fat Cat is not just fat, it's factual. You can pinpoint the switch you need by circuit, actuator, termination, rating and size in seconds. Find all necessary ordering info on a single page. Plus, you can cut, paste and design-in with precisely proportioned inch/metric drawings.

The NKK Fat Cat. It's more than a reference source for toggle, rocker, pushbutton, rotary, DIP, illuminated and custom switches. It's a valuable technical manual.

Order yours today. And once you get it, don't let it out of your sight.

Contact: NKK Switches, 14415 North Scottsdale Road, Scottsdale, Arizona 85260. 602/991-0942.

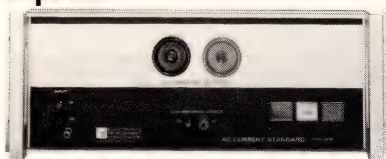
CIRCLE NO 182



NKK
switches

New Instruments

100 Amp AC Transconductance (Current) Amplifier



Model 3210/C

Easy to use, inexpensive AC current calibrator for AC current meters, watt meters, meter shunts, current to voltage transducers and digital multimeters.

Ideal reference for testing current coils.

When the 3210/C is combined with EDC's Voltage calibrators and/or interface instruments it becomes part of a watt meter or watt hour meter test system.

Output ranges: 100 and 10 Amperes AC, rms

Frequency: 50 Hz to 400 Hz

Accuracy: 0.05% of setting

Harmonic Distortion: 0.03%

Size: 7.0H x 19.0W x 13.8D inches

Weight: 40 lbs.

Price: \$2,695

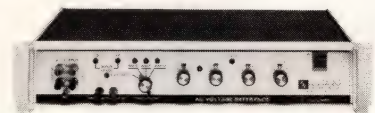
Availability: 60 days ARO

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696

CIRCLE NO 3

Low Cost AC Voltage Reference/Calibrator



Model 4032

Easy to use, light weight, inexpensive AC voltage calibrator for meters. Excellent reference for A/D converters, amplifiers, rms converters, AC gain control circuits and oscillators.

Another important application: can serve as the AC voltage reference input to transconductance (AC current) amplifiers. This effects a considerable savings over the larger, expensive AC sources.

Amplitude Output range: 10 Vac rms

Frequency: 50 Hz to 400 Hz

Accuracy: 0.06% of setting

Harmonic Distortion: 0.03%

Size: 3.5H x 19.0W x 17.0D inches

Weight: 8 lbs.

Price: \$945

Availability: 60 days ARO

Engineering Contact: **Bob Ross**

Tel: (617) 268-9696

ELECTRONIC DEVELOPMENT CORP.

11 Hamlin St., Boston, MA 02127

Tel: (617) 268-9696

TLX: 951596 (ELECDEVCO BSN)

CIRCLE NO 42

Components

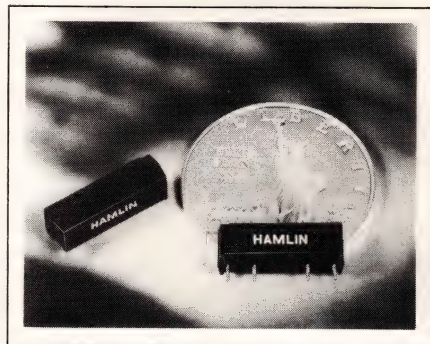
The onboard IC also provides seven levels of dimming. Additional features include the ability to blink individual characters in the string and to blink the entire string. The displays operate from a 5V supply and are TTL compatible. \$42.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303.
Phone local sales office.

Circle No 724

son Ave, Edgewater, NJ 07020.
Phone (201) 224-4700.

Circle No 725



REED RELAY

The Model HE3351A SIP reed relay features a dielectric standoff of 600V dc across the contacts and 2500V ac from the contacts to the coil. Housed in a flame-retardant molded epoxy case, the relay is supplied in Form 1A and is rated for 10W, 300V dc with a 0.5A max current-switching capability. Three coil voltages are standard—5, 12, and 24V dc. Measuring only 0.95x0.3x0.3 in., the relay is compatible with most automatic pc-board assembly and soldering equipment and is washable. \$1.07 (5000) for a 5V coil-voltage model.

Hamlin Inc, Lake & Grove Sts, Lake Mills, WI 53551. Phone (414) 648-2361.

Circle No 726



INDICATORS

Series 6000 fully gasketed indicator lights meet NEMA standards for industrial use. They are unaffected by lubricating oil, mist, rain, water, or laundry detergents. Two Buna-N O rings provide the sealing. One sits inside the bezel between the lens and the housing, and the second sits in a groove in the housing just under the bezel. The inside ring keeps liquids out of the light; the ring under the bezel compresses when you install the indicator and forms a liquid-tight seal between the light and the panel.

Some models use neon lamps (red, amber, or green) for 125 or 250V operation; these units feature an integral current-limiting resistor. Solid-state LED versions are also available for 12 or 24V operation, and these units have the current-limiting resistor and a protective diode. \$1.39 and \$1.77 (1000) for neon and LED models, respectively.

Industrial Devices Inc, 7 Hud-

DIP SWITCHES

Machine-insertable DIP switches in the 51D Series are fully compatible with standard automatic-handling equipment. They are fully sealed to withstand automatic solder and cleaning processes. The switches are available in 2- through 10-position spst configurations. Contacts are gold over nickel to ensure low contact resistance, and they are rated to switch loads of 5V at 100 mA. Pins are spaced on 0.1-in. centers.

The switch actuators are recessed to prevent accidental actuation. Insulator and cover materials (glass-

日本

Japan Electronics: A Business and Technology Update

The Japan Electronics seminar on October 7 in Osaka is designed to help European and U.S. executives seek out new business opportunities in Japan. The day-long seminar, which will coincide with the Japan Electronics Show, has been structured to provide attendees with a statistical overview of the Japanese electronics industry, as well as a preview of upcoming technological trends.

The seminar is intended both as an introduction to Japan for first-time visitors as well as an update of Japanese business and technology for seasoned travelers in the Far East. If you buy from, compete with, or sell to Japanese electronics companies, this seminar is for you.

DATE:

October 7, 1987
In conjunction with the
Japan Electronics Show

LOCATION:

Royal Hotel,
Osaka, Japan

SEMINAR FEE:

\$350

**OFFICIAL
LANGUAGE:**

English

CO-SPONSORS:

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RAI Gebouw bv of Holland
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CONFIRMED SPEAKERS:

Kaoro Kubo, vice president and general manager of NTT International. "The Japanese telecommunications industry: Opportunities for foreign suppliers"

Kazuhiko Kobayashi, manager of the Systems Engineering Division of Hitachi Ltd. "Factory automation in the Japanese computer industry"

Hiroshi Komiya, head of the Saijou Works, Mitsubishi Electric Corp. "Manufacturing technology in the semiconductor industry"

Bill Totten, president of Ashisuto K.K. "The Japanese market for U.S. and European software"

David H. Johnson, senior manager for Network Systems Sales, AT&T International. "Opportunities for U.S. communications manufacturers in Japan"

Dinker Bir, vice president of technology at Northern Telecom Japan Inc. "Trends in telecommunications"

Pat O'Malley, strategic marketing director for the Semiconductor Sector at Nippon Motorola Ltd. "The Japanese semiconductor market"

Gen Narui, regional manager for Educational Services at Nihon Digital Equipment Corp. "Recent developments in artificial intelligence at DEC"

Stephen Donovan, representative director of Monolithic Memories K.K. "Selling niche products in Japan"

Shohei Kurita, Tokyo editor for Electronic Business, author. "The Fifth Generation Computer Project"

Gene Norrett, vice president and director of the Semiconductor Industry Group, Dataquest Inc. "Electronics trends among countries on the Pacific Rim"

Alberto Socolovsky, associate publisher and editorial director of Electronic Business. "Structural differences between the U.S. and Japanese electronics industries"

Speaking on "Trends in consumer electronics":

Nobuyoshi Yokobori, manager of the R&D Planning Office, Corporate Engineering Division, Matsushita Electric Industrial Co. Ltd.

Masaru Yamano, executive vice president, Sanyo Electric Co. Ltd.

Tadashi Sasaki, corporate management advisor, Sharp Corp.

Nobuo Tateishi, executive vice president, Omron Tateishi Electronics Corp.

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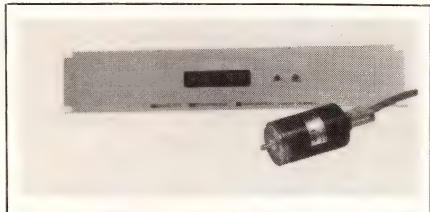
Nippon Express Nederland bv
Parnassatoren Locatellikada 1
1076 AZ Amsterdam
Tel: (020) 79 27 77

Components

filled, flame-retardant thermoplastic) carry a 94V-0 UL rating. Sturdy 0.02×0.146-in. terminals eliminate automatic-insertion problems and ensure proper alignment. \$0.72 (5000) for an 8-position model. Delivery, stock to six weeks ARO.

JAE Electronics Inc, 1901-A E Carnegie Ave, Santa Ana, CA 92705. Phone (800) 523-7278; in CA and AK, (714) 250-8770.

Circle No 727



ENCODERS

DDS90-10 scalable differential encoders provide the absolute difference between two rotating shafts with accuracies of one part in 3600. They are well suited for harsh environments and can convert any two shaft inputs to BCD or binary information. In addition, 3-, 4-, or 5-digit 0.5-in. LED displays read out the angle.

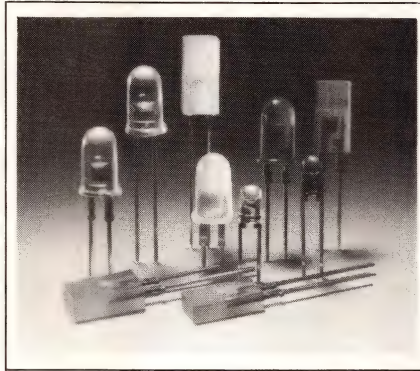
The encoders employ a resolver for the shaft transducer. An offset adjustment allows you to set the zero point, and a variety of output scale factors, including pounds, feet, and meters, are available. Data outputs are TTL compatible; data-transfer and data-hold lines simplify the interface to a computer. The basic update rate is 2.5 msec. Operation spans 0 to 70°C or -55 to +85°C. NEMA 12, waterproof, and explosion-proof transducer housings are optional. \$595/axis.

Computer Conversions Corp, 6 Dunton Ct, East Northport, NY 11731. Phone (516) 261-3300. TWX 510-226-0448.

Circle No 728

GaAlAs LEDs

This range of GaAlAs Hyper-Red LEDs includes versions with lumi-



nous intensities as high as 200 mcd for a drive current of 10 mA. The LEDs are housed in hermetically sealed plastic lenses. A refined chip-passivation technique allows the devices' GaAlAs layers to contain a high level of aluminum. The resultant high electron-injection efficiency not only provides the relatively high luminous intensities obtainable with low drive currents, but also allows you to drive the LEDs with dc or pulsed currents as high as 1A without seriously affecting their life expectancy. In addition, the high aluminum content in the GaAlAs layers produces optical radiation at a wavelength of 650 nm. At this wavelength, the human eye is more sensitive than it is at the 660- to 670-nm wavelengths typical of standard red LEDs. Approximately Gld 0.255 to Gld 0.275 (OEM qty). Delivery, six to eight weeks ARO.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 729

Dialight Corp, 203 Harrison Pl, Brooklyn, NY 11237. Phone (718) 497-7600.

Circle No 730

OPTICAL SENSOR

Suited for use in incremental angular resolvers or linear motion detectors, the SFH 910 slotted optical-sensor module has a GaAlAs infrared source and a photodiode detector separated by a 3.2-mm slot. The photodiode detector incorporates two photodiodes, 50 μ m

apart, which allow it to detect interruptions of the infrared beam and the direction in which the interruption takes place.

In addition, the module contains all the electronics necessary to evaluate the photodiode outputs so that the module can generate a pulse output and a signal to indicate the direction of movement. Both outputs are npn open-collector outputs suitable for coupling to TTL circuitry, and the pulse width of the pulse output remains constant at 10 μ sec typ. The sensor is capable of an optical resolution of 0.85 mm. Around DM 7 (100).

Siemens AG, Zentralstelle für Information, Postfach 103, 8000 Munich 1, West Germany. Phone (089) 2340. TLX 5210025.

Circle No 731

Siemens Components Inc, 186 Wood Ave S, Iselin, NJ 08830. Phone (201) 321-3400.

Circle No 732



COUNTER

The Model 706 pc-board-mounting counter has an LCD display with seven 7-mm-high digits and an over-range indicator to provide a total count as high as 19,999,999. The module automatically suppresses leading zeros. Two count inputs allow you to trigger the counter with negative edge pulses at frequencies as high as 2 kHz, or with contact closures at frequencies as high as 30 Hz. The pulse input has low and high threshold levels of $\leq 0.5V$ and $\geq 3V$, respectively, and it accepts pulses with a maximum amplitude of $\pm 30V$. Manual lockable

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UL recognized and CSA certified, Potter & Brumfield's T70 relay switches from 1 milliamp through 10 amps, resistive, on printed circuit boards. All with the same reliability and performance that have made P&B relays the industry standard. And the T70 costs as little as 77 cents in 25,000 piece quantities.

Broad range of ratings

Gold-plated fine silver or silver-cadmium oxide contacts are available in a single pole, double throw configuration. Contacts of either material are UL recognized to switch motor loads up through 1/4 horsepower at 120 volts AC. Silver-cadmium oxide contacts are also rated for 5 amp tungsten lamp loads at 120 volts AC, while silver is rated 3 amps tungsten.

Reliability? Of course!

The T70 relay features simplified construction that enhances reliability while holding cost down. A sealed version is designed for immersion cleaning, and a plastic dust cover model is also available.

Off-the-shelf service

With 20 different T70 models available from stock at P&B, the unit you need is probably available off-the-shelf. Your P&B distributor or sales representative will gladly help you select the model that's just right for your application. Call toll-free 1-800-255-2550 for the name of an authorized Potter & Brumfield distributor or sales representative serving your area. Or call your P&B regional office.

Write for free sample

Write us on your company letterhead, briefly describing your potential application for T70 relays, and we'll rush you a free sample and complete specifications. Potter & Brumfield, A Siemens Company, 200 South Richland Creek Dr., Princeton, Indiana 47671-0001.

Regional Sales:

Braintree, MA, (617) 848-6550;
San Juan Capistrano, CA,
(714) 493-4503;
Princeton, IN,
(812) 386-2130;
Bristol, England,
(0454) 616263.

Potter & Brumfield A Siemens Company

CIRCLE NO 109

**Potter & Brumfield Inc., 200 S. Richland Creek Dr.,
Princeton, IN 47671-0001**

☐ Please send more information about P&B T70 relays.

Name _____ Title _____
Firm _____ Address _____
City _____ State _____ Zip _____
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8701

EDN072387

Components

and remote electronic reset facilities are standard. The module requires a 3V dc supply and consumes maximum supply current of 30 μ A (typically 20 μ A). It has a pc-board footprint of 24×48 mm and a height of 11 mm. \$17.15 (100).

Hengstler GmbH, Postfach 100, 7209 Aldingen 1, West Germany. Phone (07424) 891. TLX 760422.

Circle No 733

Hecon Corp, 15 Meridian Rd, Eatontown, NJ 07724. Phone (201) 542-9200. TLX 132457.

Circle No 734

DMOS FET

Capable of switching 200 mA with a gate drive voltage of 5V, and of operating with drain-source voltages as high as 60V, the ZVN4106F n-channel DMOS FET is suited to interfacing high-voltage devices to logic-level circuitry. The FET has an on-resistance of 2.5 Ω at a drain

current of 500 mA and a gate-source voltage of 10V (typically around 3.3 Ω at a drain current of 100 mA and a gate source voltage of 5V). Its power rating is 250 mW. The input capacitance is 35 pF, allowing the FET to achieve switching times of less than 10 nsec typ. It comes in a SOT-23 package and is available in 8-mm tape and reel format for use with automatic-placement equipment. \$0.185 (10,000).

Ferranti Electronics Ltd, Fields New Rd, Chadderton, Oldham, Lancashire OL9 8NP, UK. Phone 061-624 0515. TLX 668038.

Circle No 735

Ferranti Electric Inc, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200. TLX 6852104.

Circle No 736

OPTOCOUPERS

Featuring single heterojunction

GaAlAs infrared emitters, the PO40/44A, CNG35, CNG36, CNR36, 6N135, and 6N136 optocouplers boast long lifetimes without undue loss of performance. After 10,000 hours of operation, their current transfer ratio falls by only 5%, compared to the 40% drop often found in GaAs types. In addition, their current transfer ratio at low drive currents (0.5 typ for the CNG35 at 500- μ A drive current) allows you to drive them directly from CMOS logic. This low drive-current capability also improves the transfer linearity when they transfer analog signals.

The PO40/44A UL-recognized optocouplers pass British Telecom's input-diode overstress tests (100 mA for 96 hours, then 300 mA for 72 hours) while exhibiting less than 7% drop in current transfer ratio (maximum allowed 25%, average allowed 10%). The CNG35 and CNG36 provide 4.4-kV isolation between input



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*Philips, Elcoma Div, Box 523,
5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.*

Circle No 739

*Amperex Electronic Corp,
George Washington Hwy, Smithfield, RI 02917. Phone (401) 232-0500.*

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SGS-Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

Circle No 737

SGS Semiconductor Corp, 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

Circle No 738

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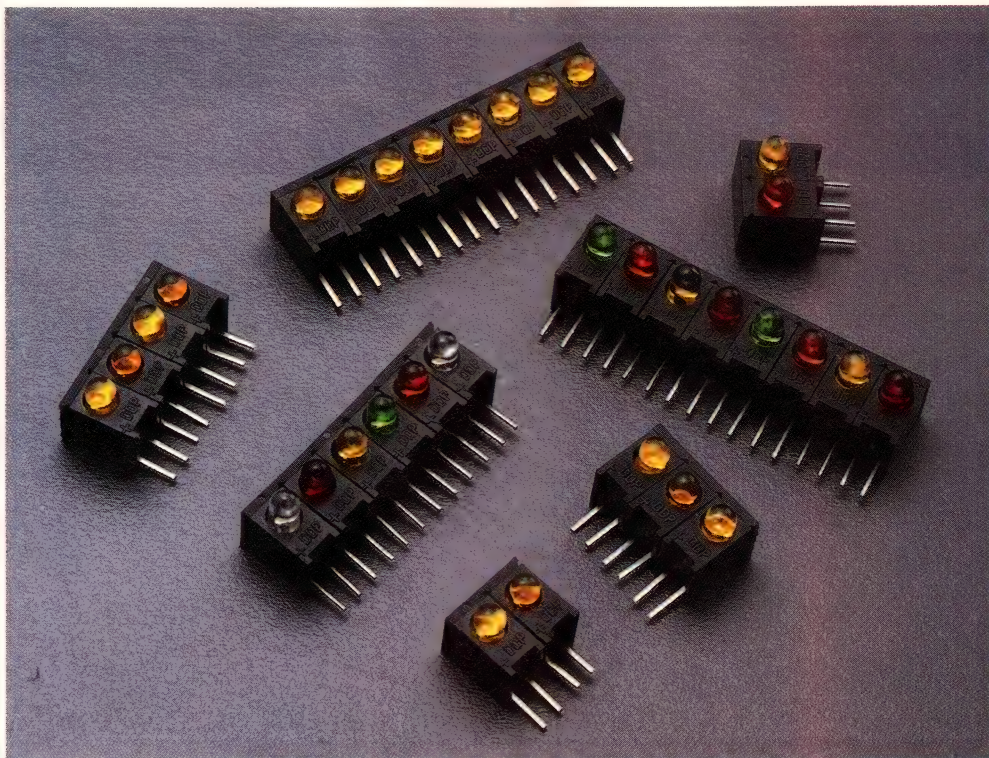


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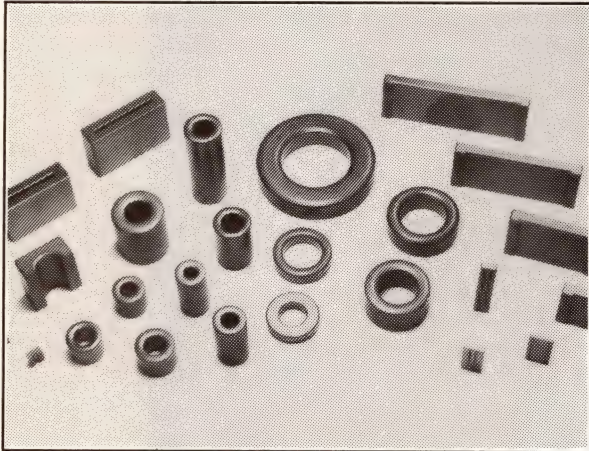
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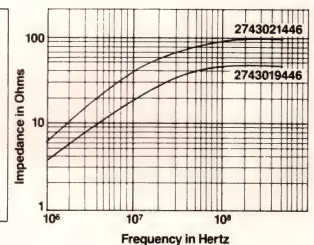
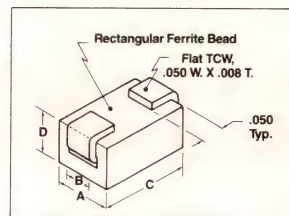
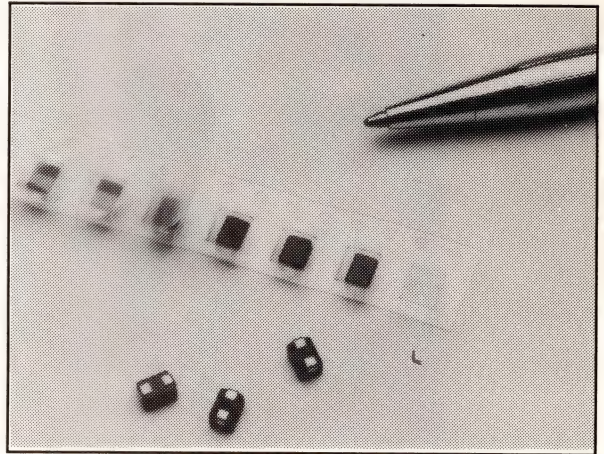
Each kit comes with its own Engineering Bulletin describing the contents and guiding the designer in the use of Fair-Rite components to solve EMI problems.

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Introducing SM Beads™ (Surface Mount Beads)

Ferrite EMI suppressors expressly for use with
Surface Mount Technology



Fair-Rite Part No.	A Dim	B Dim	C Dim	D Dim	Z @ 25 MHz*	Z @ 100 MHz*	DC Resistance Ohms
2743019446	.115 .125	.055 .060	.150 .170	.095 .105	30	45	< .6 Milliohms
2743021446	.115 .125	.055 .060	.325 .345	.095 .105	60	90	< .9 Milliohms

Surface Mount Technology is fast becoming the preferred method of PC Board assembly. Recognizing the need for surface mount EMI suppressors, Fair-Rite Products is introducing a line of Surface Mount Shield Beads (Patent applied for) to supplement our current array of EMI/RFI Suppressor elements. The two parts available at present offer equivalent impedances to our most popular "beads-on-leads" and can be used in place of the older technology.

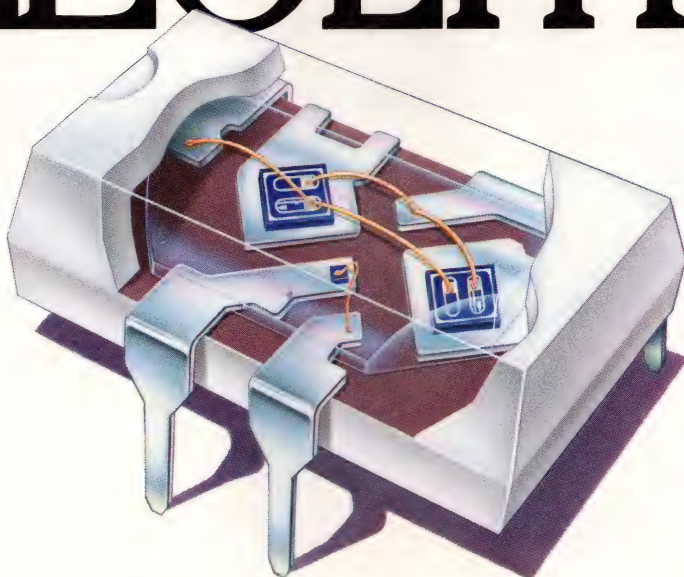
The construction of these SM Beads™ is such that they offer maximum current carrying capacity, through solid flat copper conductors rather than metal plating, limited only by the saturation characteristics of the ferrite core material, and thus are highly resistant to mechanical or magnetic failure. These parts are available taped and reeled on carriers, per EIA Standard EIA-481A, at a price that makes them a most attractive method of designing EMI protection into circuitry from its inception.



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Beyond FET: SIT, from Tokin.

Tokin introduces SIT (Static Induction Transistor), an all new high-power vertical field effect transistor featuring unsaturated current and low drain-to-source resistance.

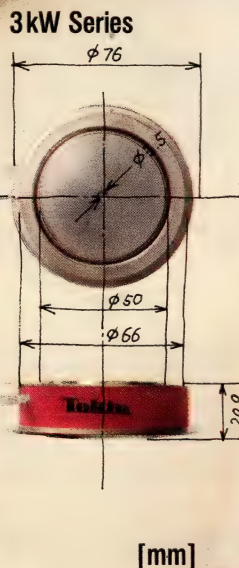
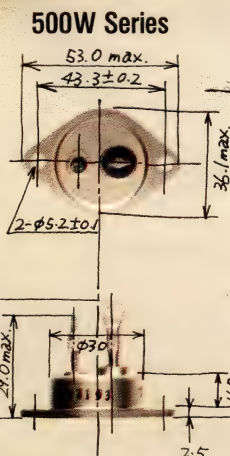
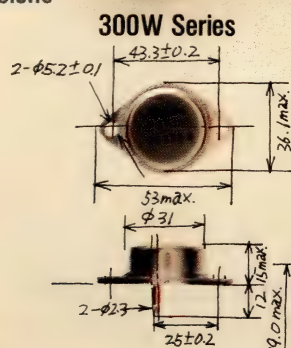
Tokin accomplished this by minimizing gate resistance and high frequency signal loss. And its heat-proof design and negative temperature coefficient eliminate spot concentrations of current and reduce thermal discharge.

This means SIT can be used for a wide range of practical high-frequency, high-power applications, from high-power ultrasonic devices to induction heaters, from power supplies for lasers to amplifiers and transmitters.

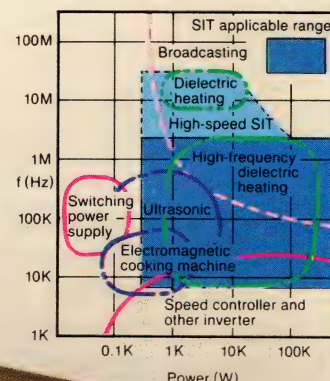
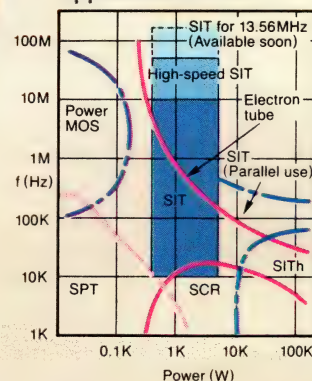
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Shapes and Dimensions



Applications of SIT



Electrical Characteristics (Ambient Temperature: 25°C)

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Storage Temperature	-50 ~ +150°C												
Gate to Source Voltage	70V												
Gate to Drain Voltage	600V	800V	600V	800V	1200V	1500V	600V	800V	1200V	1500V	600V	1200V	1500V
Drain Current	20A			60A				60A			200A		180A
Total Power Dissipation	300W			500W				1000V				3000W	
Insertion Gain	10"			12"			10"			12"		10"	12"
Cutoff Frequency	10MHz*			10MHz*			10MHz*					7MHz	
Drain to Source ON Resistance	1.5Ω max.	20Ω max.	1.0Ω max.	1.5Ω max.			1.0Ω max.	1.5Ω max.			0.3Ω min.		0.5Ω max.
Turn-On TIME	200ns*			250ns*				250ns*				350ns*	
Turn-Off TIME	250ns*			300ns*				300ns*				350ns*	

* Nominal value

CIRCLE NO 179

Tokin

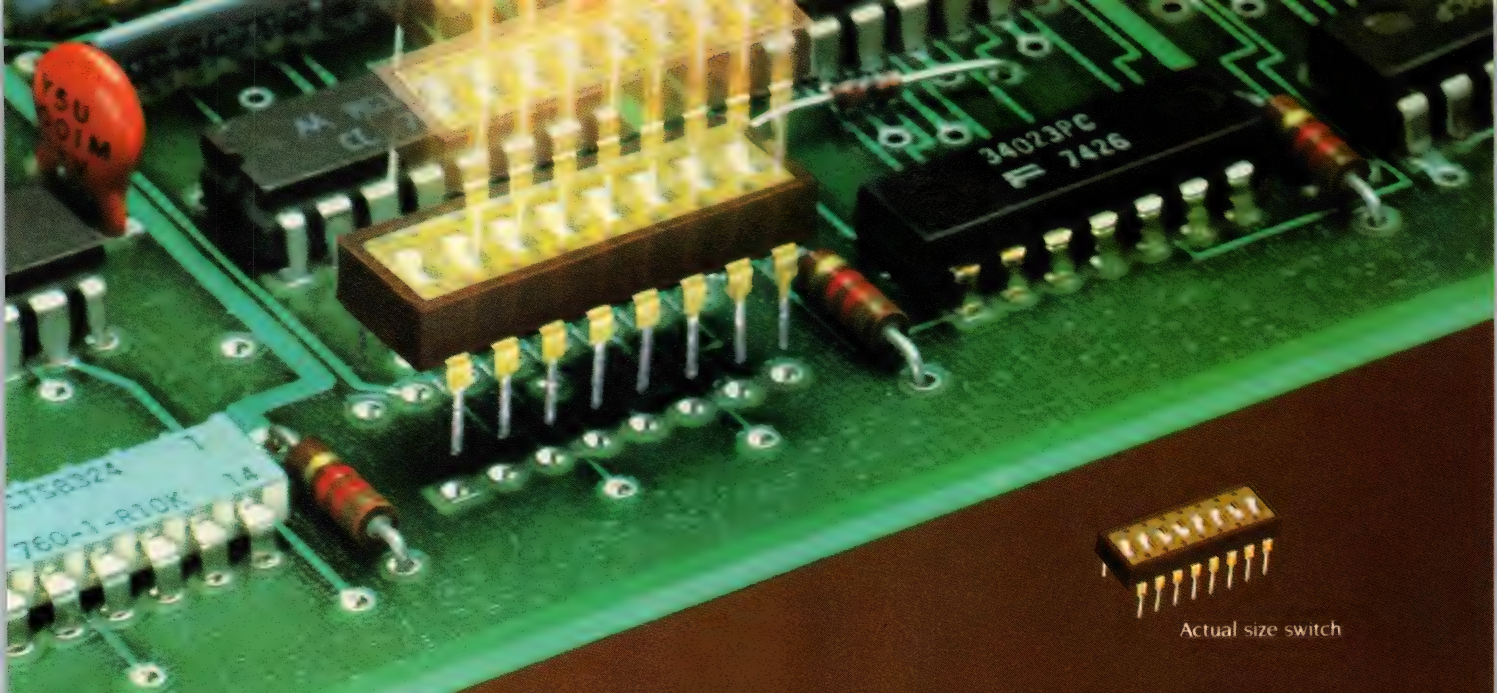
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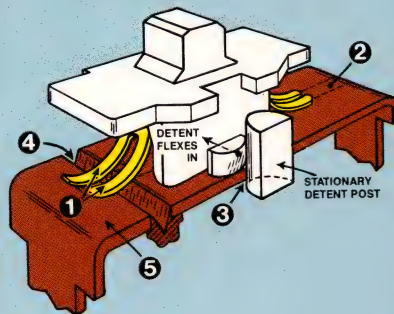
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CIRCLE NO 9

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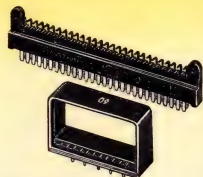
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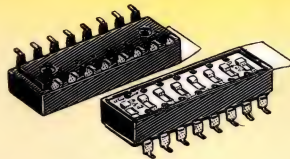
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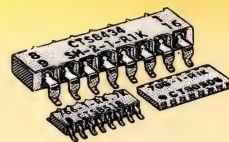
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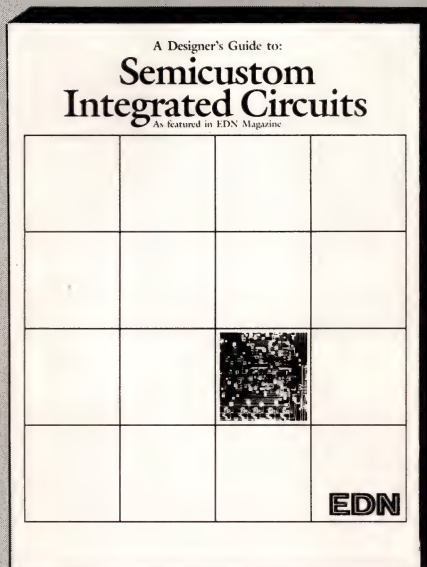


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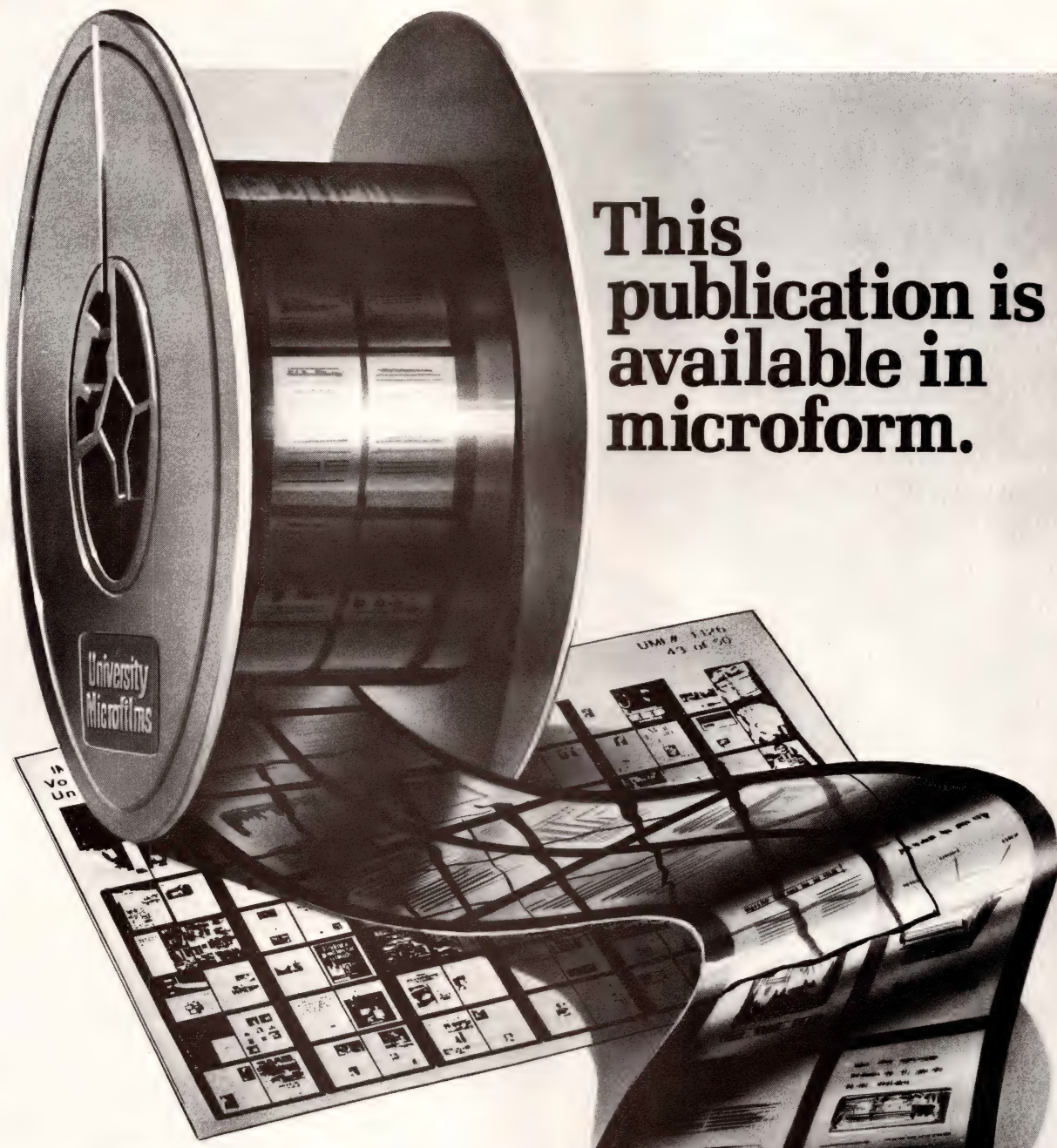
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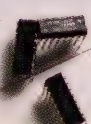
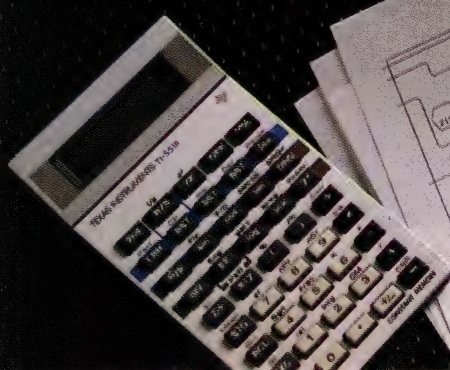
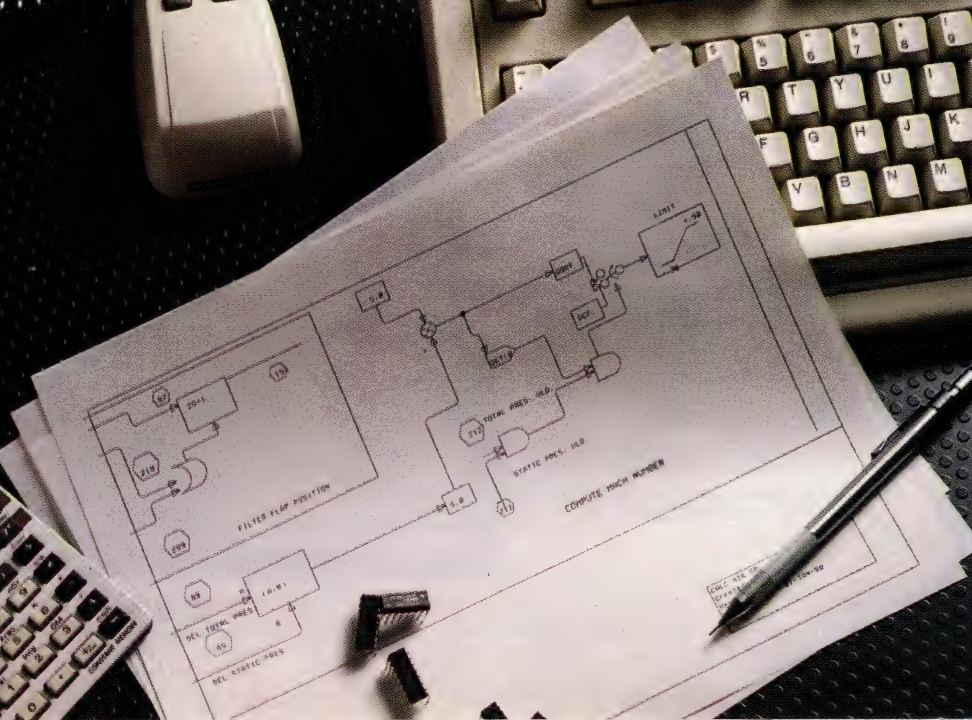
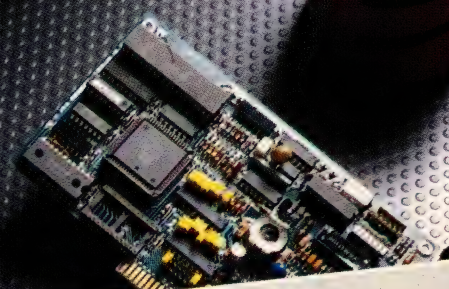
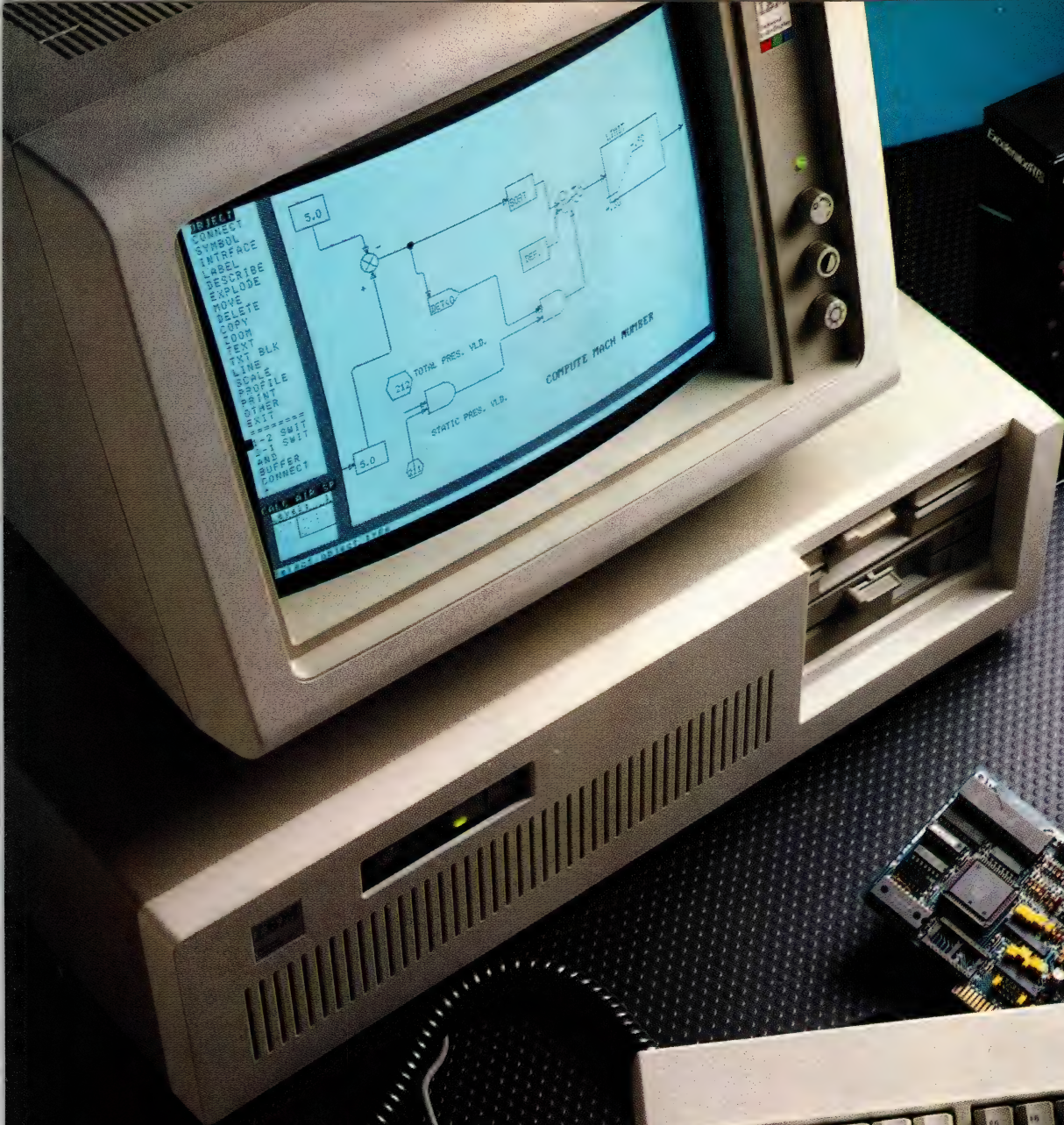
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CASE tools run on an expanded range of computer systems

Chris Terry, *Associate Editor*

Once available only for the largest computers, CASE tools now suit a range of computers and applications. The various tools can be invaluable both for creating maintainable software and for heading off, in the design stage, potentially devastating problems that could be expensive to correct later on.

COMPUTER-AIDED SOFTWARE ENGINEERING (CASE), which was once the software developer's impossible dream, is now a reality. CASE tools are currently available for a wide variety of computer systems, including inexpensive minicomputers such as IBM PC/XT clones. To facilitate different kinds of software design, the tools use different design methodologies, and some of the tools are flexible enough to use a number of different methodologies. Further, many CASE vendors are recognizing the need to develop interlocking tools to cover the whole life cycle of a design.

CASE still has a long way to go before reaching maturity. Software vendors are working now to overcome one of the greatest challenges of CASE—that of reconciling the different internal data formats of various companies' CASE tools so that data will be easily transferable from one tool to another. Compatibility among the internal data formats used by different vendors will prevent problems and delays in complex software projects that are divided up among different subcontractors. For now, however, you can indeed use CASE tools to enhance your software designs and to detect, at an early stage, problems that could be expensive to correct later on.

A little CASE history

The underlying ideas of CASE are not new; they are an outgrowth of the philosophy of structured programming, which has its roots in the early 1970s in the teachings of Niklaus Wirth and Edsger Dijkstra. Structured programming was the first effort at applying to software the principle of modularity—the use of independent, reusable building blocks, each of which performs a single function. This principle was already appearing in the construction of bus-based hardware.

The available CASE tools fall into two basic categories: first, tools that clearly and precisely define what a proposed software system will do, and second, tools that specify the actual software modules for fulfilling these requirements. The modules can be converted to high-level code. These two types of tools provide for consistency among different sections of a system regardless of how many people are developing the system. CASE software vendors, however, adhere to a number of different schools of thought on how to implement these ideas.

The three most popular methods (and symbols) for keeping a

**CASE tools provide for
consistency among different sections
of a software system regardless of how
many people are developing the system.**

design consistent and complete are those of the Yourdon/DeMarco, Nassi/Schneiderman, and Warnier/Orr schools of thought. The Yourdon/DeMarco methodology includes DeMarco's data-flow diagrams (DFDs) for system requirements and Gane and Sarson's structured-design notation for program building. The Warnier/Orr method employs stepwise-refinement charts. The Nassi/Schneiderman school uses decision tables and diagrams called "structograms," which are derived from the tables. Many of the available CASE tools, particularly those that run on the IBM PC family and clones, follow one of these schemes; the Yourdon/DeMarco group appears to predominate. However, a number of other, proprietary systems of notation have also emerged.

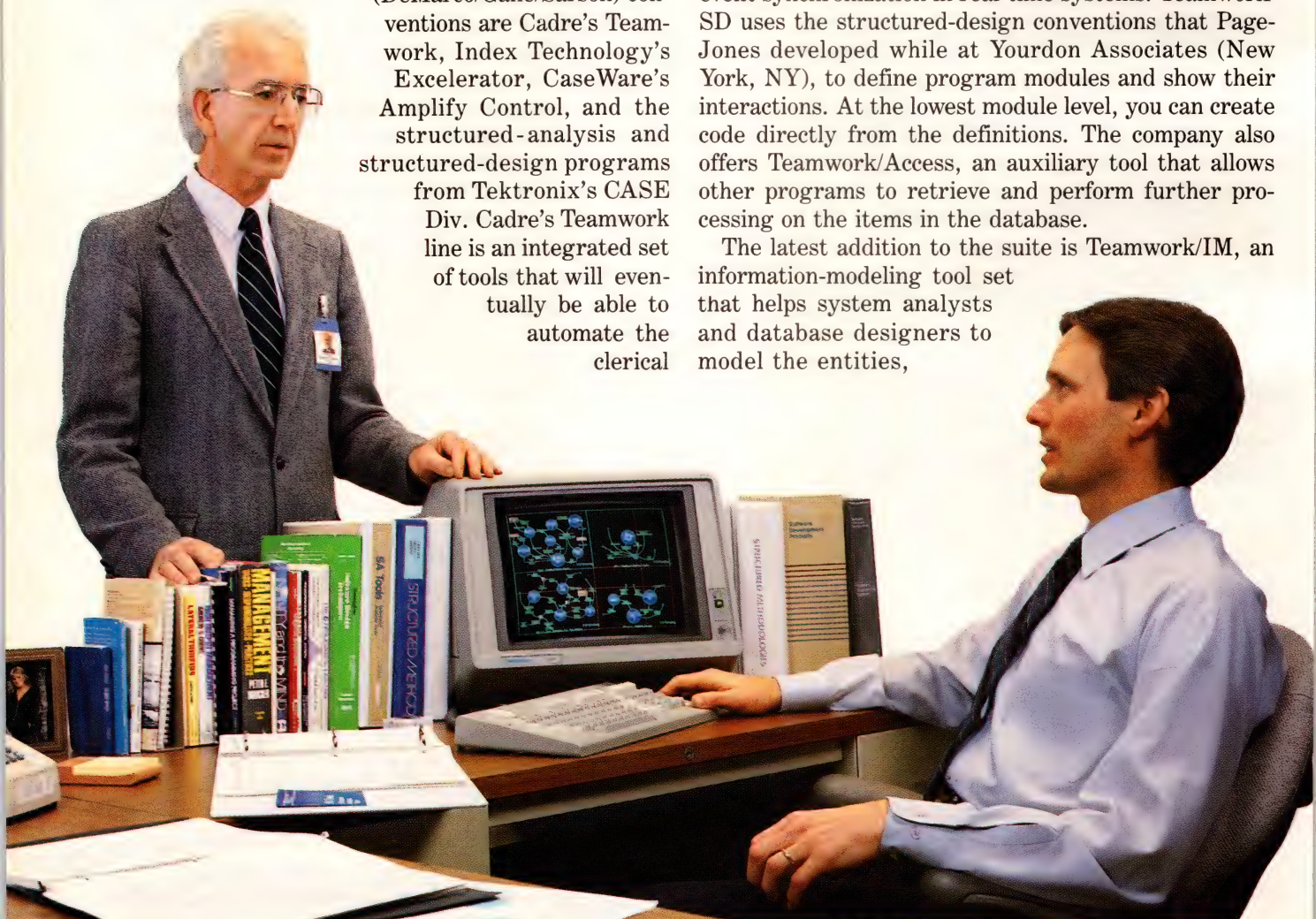
Typical of the products that use the Yourdon (DeMarco/Gane/Sarson) conventions are Cadre's Teamwork, Index Technology's Excelsior, CaseWare's Amplify Control, and the structured-analysis and structured-design programs from Tektronix's CASE Div. Cadre's Teamwork line is an integrated set of tools that will eventually be able to automate the clerical

portions of all phases of a software system's life cycle. Each program costs \$8900; a combination of Teamwork/SD with Teamwork/SA or Teamwork/RT costs \$12,500. Hewlett-Packard supplies Teamwork modules that run on its Series 300 workstations.

Teamwork/SA is a structured-analysis tool that was originally developed for the Domain workstations from Apollo Computer Corp (Chelmsford, MA) but that is now available for VAX/VMS systems as well. Teamwork/SA strictly follows the DeMarco methodology, using data-flow diagrams (DFDs) linked to a database containing a data dictionary (for data definitions) and minispecifications (for process definitions).

Teamwork/RT is similar to Teamwork/SA, except that it also provides the DFD extensions developed by Derek Hatley of Lear-Siegler to show control flow and event synchronization in real-time systems. Teamwork/SD uses the structured-design conventions that Page-Jones developed while at Yourdon Associates (New York, NY), to define program modules and show their interactions. At the lowest module level, you can create code directly from the definitions. The company also offers Teamwork/Access, an auxiliary tool that allows other programs to retrieve and perform further processing on the items in the database.

The latest addition to the suite is Teamwork/IM, an information-modeling tool set that helps system analysts and database designers to model the entities,



Structured-analysis and -design tools for VAX/VMS systems (Tektronix)

A look at the future of CASE

Software developers are taking a hard look at CASE to reevaluate its advantages and the direction it's taking. In May 1987, approximately 250 software engineers convened at CASE '87, the first international workshop on CASE, to discuss current and future developments in this field. Participants in a panel discussion entitled Support Between Methods and Tools agreed that no one of the existing CASE methodologies is adequate to serve all applications.

Forums such as the CASE conference may lead to agreement among software developers on a means of swapping data among CASE programs. It may also generate fresh ideas and possibilities for CASE's future development. It's possible, for example, that such discussions and think tanks will lead to new methodologies for CASE.

Already a number of software engineers are challenging conventional ideas about CASE. For example, database developers at the conference pointed out that they find the Yourdon methodology inadequate for their needs; they cited methodologies based on data-structure specification and transformation as more productive than process-definition methodologies. A number of conference participants also ex-

pressed concern that data-flow diagrams, though useful for some immediate software-development tasks, might inhibit CASE's future progress.

Many of the speakers emphasized that, on the whole, it's better for a tool to follow one methodology, and follow it rigorously, than to allow a mixture of methodologies within a single design project. However, they admitted, certain CASE tools suit particular kinds of users, just as they suit particular applications: Relatively inexperienced analysts will require the more rigid methodologies; experienced analysts will need the freedom to use unconventional methods in achieving their goals.

One person questioned the current reliability of code generators and (to murmurs of assent) said he thought that, for several years to come, analysts and programmers would be manually checking all code emitted by such generators. He did not doubt, however, that reliable code generators would eventually arrive, and may even exist already.

Speakers at CASE '87 also made it clear that CASE implementations for the future are going to have to be increasingly flexible. At certain of the confer-

ence's panel discussions, participants generally agreed that the communication of results from one tool to another, both within a tool set and from system to system, is essential. EDIF was suggested as one possible way of achieving this goal.

In projecting the future of CASE, conference participants drew comparisons between CASE and CAE. A number of speakers pointed out that deficiencies still exist in both CASE and CAE, notably in their databases and user interfaces, and that much work needs to be done in these areas if the tools are to become widely used and accepted. One speaker asserted that it has taken 20 years to develop graphics protocols that are fully accepted, and CAE/CAD/CAM will take two more years to reach the same level of acceptance. He prophesied that a corresponding acceptance of CASE tools would require four more years; thus, CASE would probably be regarded as reliable and mature in the early 1990s.

If you're interested in participating in the planned CASE '88 conference, write to Jessica Solodar, Index Technology, 1 Main St, Cambridge, MA 02142, or call her at (617) 494-8200.

relationships, and attributes of all application data in a system. Teamwork/IM lets you create and edit entity-relation diagrams (ERDs), using the industry-standard Chen notation. Associated utilities can automatically create data declarations in the programming language of your choice, using the contents of the data dictionary as input. If you wish, you can use Teamwork/SA to create DeMarco DFDs from a database created by Teamwork/IM.

The CASE Division of Tektronix supplies a set of tools that are very similar to those of Cadre. The Tektronix CASE tools run on most VAX machines; prices start at \$16,500.

Interactive Development Environments offers Software Through Pictures, which runs on Apollo Domain workstations, Sun workstations, and DEC's VAXsta-

tion under the Ultrix or VMS operating systems. Prices start at \$5000 for the first node. The package consists of the Data Flow Diagram editor, Structure Chart editor, Data Structure editor, and Entity-Relationship editor. Other tools in the package check your design diagrams for consistency and completeness. In constructing DFDs, you can use either the DeMarco or the Gane/Sarson symbols, with the Hatley extensions for real-time systems.

The Data Structure editor uses Jackson's notation; from the data in the data dictionary, the editor can automatically generate the formal grammar for the data structure, using the Backus/Naur form. In addition, the editor can construct data declarations in C, Pascal, and Ada.

The Structure Chart editor lets you develop the

**Some CASE vendors advocate
adherence to a single CASE methodology;
others emphasize versatile tools that
let each designer use the methodology
that suits him best.**

module structure of your system, using the Yourdon/Page-Jones symbols. You enter your definitions with the aid of a template that has place holders for various types of information about a module. The editor automatically extracts (from the data dictionary) information about the calling structures and I/O parameters and inserts this information into the template, which you can then edit or expand as necessary.

For database development, you can use the Entity-Relationship editor, which defines entities, relationships, and attributes in Chen notation. The ERE has an automatic schema generator that allows you to evaluate several different designs very quickly. Prices range from \$5000 to \$25,000, depending on the hardware configuration.

Communication vs versatility

Although Cadre adheres closely to the structured-analysis and structured-design methodologies developed at Yourdon Associates, the company regards linkage to CAE/CAD/CAM and documentation tools as extremely important. Lou Mazzucchelli, one of the company's founders, states that because hardware architecture inevitably affects software structure to some degree (and, in a new system, software goals may influence hardware design), there will always be a need to use CAE design fragments in CASE procedures, and vice versa.

Mazzucchelli advocates strict adherence to a single, widely accepted methodology for CASE tools. He also favors the adoption of an industry-wide standard data format to permit the transfer of data among different tools and even across the boundaries of systems with widely differing hardware architectures. He suggests that the Electronic Design Interchange Format (EDIF), for which there is growing support, may provide such a standard. By the time you read this, it is likely that EDIF utilities will permit the Context (Beaverton, OR) documentation system to access Teamwork databases for the automatic generation of system documentation.

Although it agrees with Cadre that data interchange is necessary, Index Technology focuses primarily on providing versatility in CASE tools so that a designer can use whichever methodology best suits his application. Rick Swanborg, director of operations at Index Technology, doesn't think software developers should insist on using only one particular methodology. He points out that no single technique can be optimal for all applications, quoting as an example the fact that the

DeMarco system can't adequately represent real-time systems (Derek Hatley solved this problem by creating certain extensions to the DeMarco system).

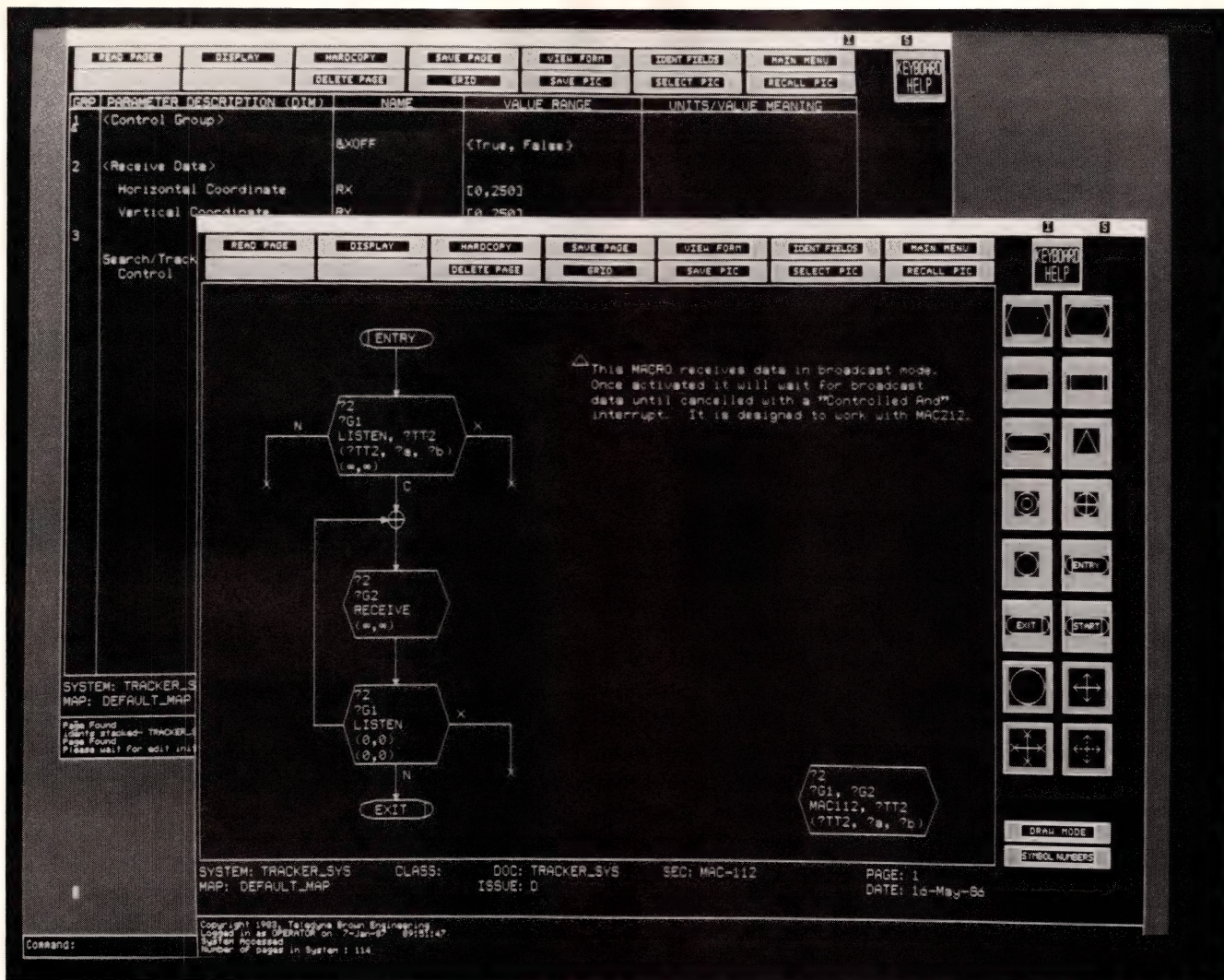
Index Technology's Excelerator, which was originally developed to run on IBM PCs and compatibles, is now available for VAXstations that run the VAX/VMS operating system. Both versions are priced at \$8400. Multiple users of Excelerator who develop software systems on the VAXstations can share project and design data across a DECnet network, using the host VAX for data storage, analysis, and other processing tasks. Excelerator lets you use DeMarco or Gane/Sarson DFDs, Jackson or Page-Jones structure diagrams, Chen and Merise ERDs, and Bachman data-model diagrams. Therefore, if you're familiar with any one of these methodologies, you'll be able to get this tool up and running right away. You can also use the tool in conjunction with other structured methodologies and, if you wish, you can even mix different methodologies within a single system design.

For real-time and embedded systems, Excelerator/RTS lets you use either Hatley or Ward/Mellor real-time extensions to specify and represent the timing and control requirements. The Customizer, a \$12,500 option for the Excelerator package, allows you to tailor the data dictionary and its user interface so that the dictionary will work with your specific design data, analysis routines, and interface products. It runs on IBM PCs and most IBM PC compatibles equipped with at least 640k bytes of RAM. Other optional utilities are also available.

Special-purpose CASE tools

Among the CASE software packages that use the Nassi/Schneiderman conventions are Maestro from Softlab and X-Tools from Software Design Tools. Unlike most of the other systems described here, Softlab's Maestro includes both a text editor and an automatic source-code generator, as well as project-management tools. It runs on a multiuser minicomputer (Motorola 4000 Series IV/90 and IV/95) and special terminals that have a large number of function keys.

You can link the Maestro minicomputer to one or more host mainframes that will run the programs you develop on the Maestro. The structured-design facilities include the use of decision tables and Nassi/Schneiderman structograms. You define the elements of the system in the company's proprietary Structure Language; the syntax of this language allows a code generator to transform a structogram into source code.



Proprietary CASE package for the vendor's workstations (Teledyne Brown Engineering)

The vendor also offers code generators for the major programming languages. The software for a 32-user system includes both Maestro and Project Manager Plus and costs \$97,000.

X-Tools, developed by AiD GmbH (Oberkochen, West Germany) and marketed in the US by Software Design Tools, is a set of CASE tools that run on small computers under the CP/M, CCP/M, PC-DOS, VMS, and other minicomputer operating systems. The package consists of a structogram editor for constructing Nassi/Schneiderman structograms, a source-text generator that converts the structogram into source text for a high-level language, and a precompiler that checks the syntax and semantics of source text generated by the structogram editor, and converts the source text into formal source code. The precompilers are available for C, Basic, Pascal, PL/M, Fortran-77, and Cobol. The X-E-Fortran tool set costs \$395 for the IBM PC and \$3850 for the VAX/11 (running VMS).

Among the adherents to the Warnier/Orr school of thought is Ken Orr & Associates, whose \$12,500 Design Machine package automates the requirements-definition phase of the vendor's Data Structured Systems Development (DSSD) tool set. The Design Machine

runs on IBM PCs and compatibles and uses Warnier/Orr stepwise-refinement diagrams to break a problem into subproblems. DSSD stores your data and process definitions in a central database and automatically enforces rigorous conformance to the methodology. From the database, DSSD automatically produces other diagrams that represent information about data entities, transactions, and their relationships, and it generates a complete output-requirements report. To aid in enforcing quality-control rules, built-in checkpoints require you to declare the completion of each deliverable module before proceeding.

Proprietary methodologies for CASE

Besides the packages that use the popular CASE methodologies, a number of CASE packages use proprietary methodologies. CaseWare Inc, for instance, offers the Amplify Control package (\$9800) as the foundation of a software-development environment that embraces all the phases of a software system's life cycle, from specification of system requirements through module design and coding to maintenance and version control. This tool runs on Sun Microsystems workstations under Unix. It currently focuses on the development of soft-

**Eventually, vendors will link
CASE tools with CAE/CAD/CAM and
documentation tools, creating a single
database that all of a system's
programs can draw upon.**

ware written in C, although the vendor plans to make it available soon for other workstations and programming languages.

The tool consists of three parts: a structure diagrammer that lets you define the physical structure of a software system and check the definitions for consistency and completeness; a version manager that automates the management of version-release data and lets you extract source code for an entire system with a single command; and a makefile generator that automatically creates command files that the Unix *make* utility can use in building and modifying a software system. Under development are modules for software design (with Yourdon DFDs, Hatley control-flow diagrams for real-time systems, and Chen ERDs for database systems) and modules for project management, software documentation, and automatic code generation.

The Epos system, from Software Products and Services, consists of seven components that run on a variety of machines, including the IBM System/370, DEC's VAX/VMS systems, IBM's PC/AT, and Intel's 8086/

RMX and 286/RMX machines. English text is the main input to the requirements-specification module; this module also provides facilities for mathematical modeling and establishing a project lexicon. The system specification lets you structure the system with the aid of decision tables and Nassi/Schneiderman structograms. The analysis module checks the structure for consistency and completeness. Other modules provide for system documentation, project specification, project management, and communications. Prices start at \$12,500 for the MicroVAX version. There is an additional charge for user training, which is mandatory for purchase.

Teledyne Brown Engineering offers TAGS (Technology for the Automated Generation of Systems). This system runs on the vendor's TBE300, TBE660, and TBE460 workstations and uses a special Input/Output Requirements Language (IORL) to combine system specification, module design, and system documentation into a single iterative process consisting of specification, validation, and respecification. The documenta-

For more information . . .

For more information on the CASE tools discussed in this article, circle the appropriate number on the Information Retrieval Service card or contact the following manufacturers directly.

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Case Technology Inc
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Mountain View, CA 94043
(415) 962-1440
TLX 506513
Circle No 561

CaseWare Inc
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Costa Mesa, CA 92626
(714) 754-0308
Circle No 562

Hewlett-Packard Co
Logic Systems Div
Box 617
Colorado Springs, CO 80901
(303) 590-5889
Circle No 563

Higher Order Software Inc
Box 178
Somerville, MA 02143
(617) 628-8500
Circle No 564

Index Technology Corp
1 Main St
Cambridge, MA 02142
(617) 494-8200
TWX 910-380-7014
Circle No 565

Interactive Development Environments
150 Fourth St, Suite 210
San Francisco, CA 94103
(415) 543-0900
TLX 184324
Circle No 566

Ken Orr & Associates Inc
1725 Gage Blvd
Topeka, KS 66604
(913) 273-0653
Circle No 567

Softlab Inc
188 The Embarcadero
Bayside Plaza
San Francisco, CA 94105
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Circle No 568

Software Design Tools Inc
Sunset/Vine Tower, Suite 1126
6290 Sunset Blvd
Los Angeles, CA 90028
(213) 463-6102
TWX 910-321-2903
Circle No 569

Software Products & Services Inc
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New York, NY 10016
(212) 686-3790
TLX 852616
Circle No 570

Teledyne Brown Engineering
300 Sparkman Dr
Cummins Research Park
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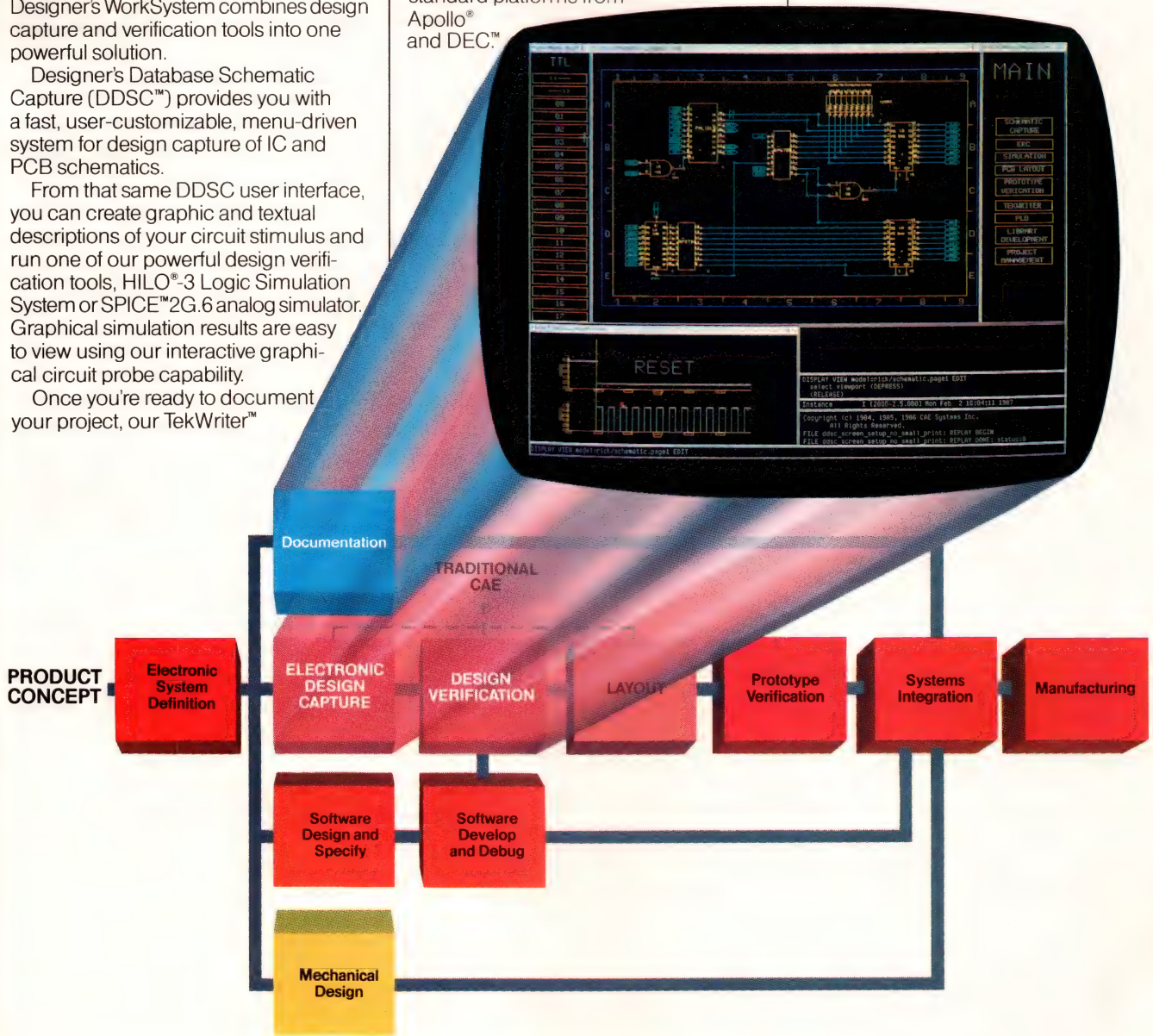
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tion processor can extract from the database all the information it needs to construct comprehensive documentation that you can later edit and refine. The syntax of the IORL is such that code-generator modules can generate source code for Ada and other high-level languages. The software package starts at \$5000, depending on the hardware configuration.

Higher Order Software offers USE.IT, a package based on functional decomposition of the system requirements into a tree structure. You first specify the tree structure with the aid of the graphics editor; then you define control maps that define specific operations within your application. Analysis facilities check your design for consistency and completeness, and a code generator converts your specifications to source code in Fortran or another high-level language. The IBM PC version costs \$5000; the MicroVAX version costs \$45,000 per CPU; the VAX/VMS version is priced at \$92,000; and the IBM MVS version sells for \$95,000.

CASE vendors are gradually moving toward seamless integration of the modules within their proprietary CASE packages. Because of the increasing interdependence of hardware architecture and software design, however, the vendors are going to have to go even further. Eventually, they will link CASE tools with CAE/CAD/CAM and documentation tools, creating a single database that all of a system's programs can draw upon.

The next step will be to find a means of transporting both CAE and CASE data across system boundaries, providing a common method of exchanging data among the various tools, which often serve very different applications and run on different machines. EDIF may provide the standard vehicle for such exchange. **EDN**

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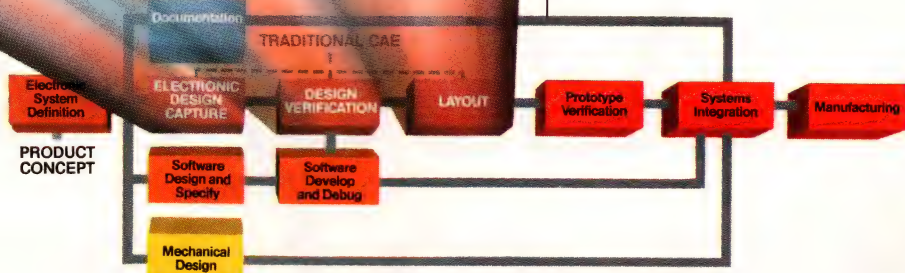
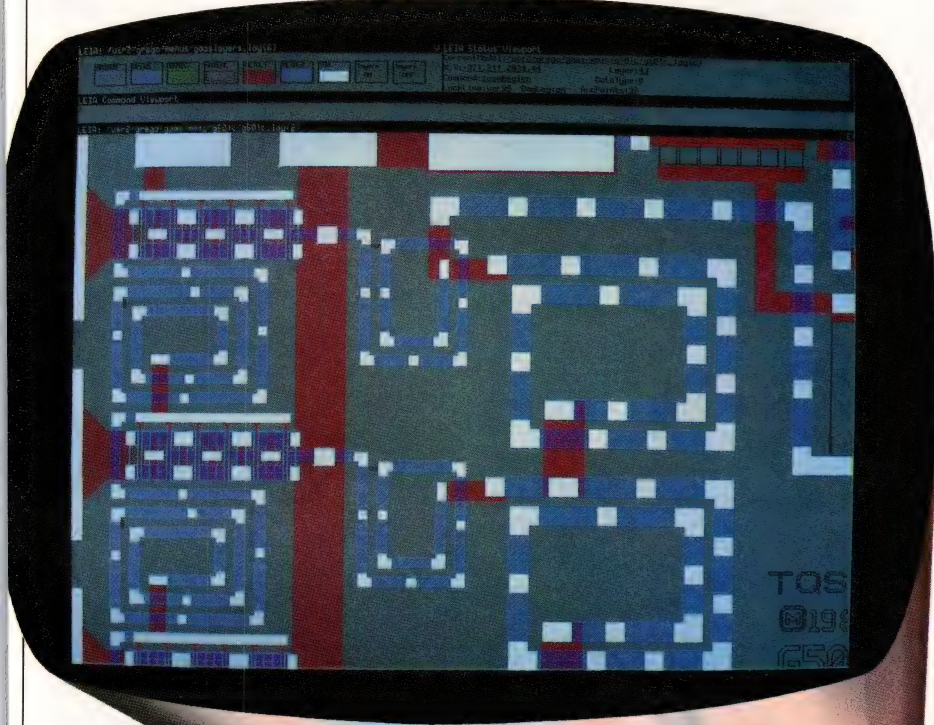
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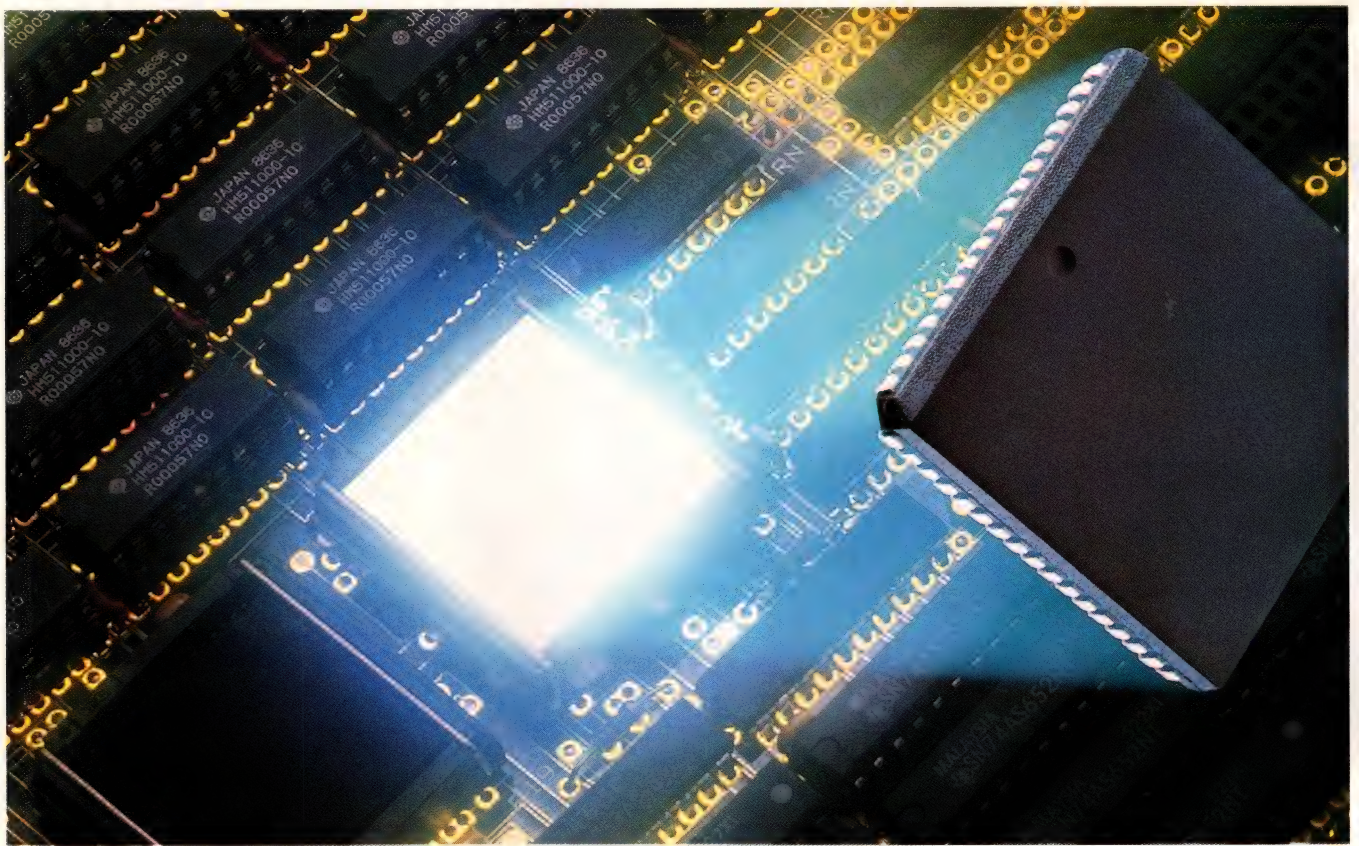
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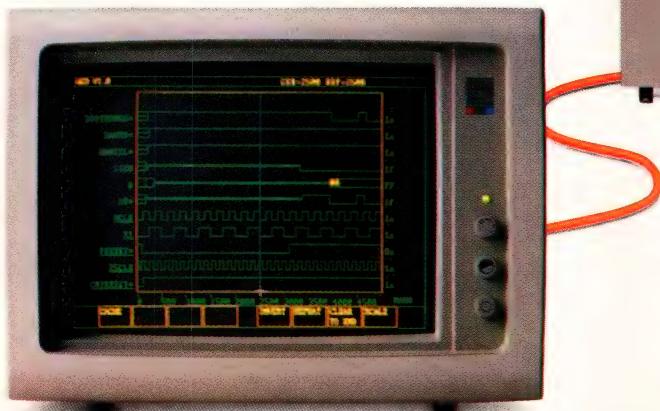
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combine... to offer
CAE solutions
that work!"*



CASE Technology's new Vanguard CAE Design System, in combination with Digital's VAX-based engineering workstations, provides one of the most complete computer-aided engineering solutions available. The system includes schematic capture for PCB and ASIC design, digital logic simulation, circuit simulation and PCB design capabilities.

The strength of the Vanguard CAE design solution is its flexibility. With DECNet and DECNet/DOS, using VAX minicomputers and workstations linked with standard personal computers, an entire engineering facility can be networked, creating a completely integrated design automation environment.

The Vanguard system can also be utilized as a front-end CAE design tool for users that need to integrate existing

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With more than 3000 installed systems worldwide, CASE Technology has developed a solid reputation as a premier supplier of professional CAE design tools. If you haven't seen what CASE has to offer, then now is the time.

CASE Technology Inc., 2141 Landings Drive,
Mountain View, California 94043
Phone (415) 962-1440; Telex 506513;
Fax (415) 962-1466

**CASE
TECHNOLOGY**

"CAE Solutions Planned *Right* from the Start"

Computer-Aided Engineering

Five silicon-compiler software packages aid process of system and chip design

The originally general-purpose Genesil program is available as five individual special-purpose packages: MacroCompiler, LogicDesigner, ChipBuilder, Mentor Series, and Server.

MacroCompiler compiles cell blocks, but it can't combine the blocks into a complete IC layout. The package generates a geometric database and a logic-simulation model of each block.

LogicDesigner doesn't lay out complete ICs either, but it calculates device speed and die size in addition to compiling blocks. To estimate the characteristics of a completed IC, the program creates a layout in generic 3-, 2-, and 1.25- μ m processes. Once you're satisfied with a design's speed and size, you

can transmit a LogicDesigner file to the company's Prototype Tapeout Service, which optimizes the layout and places orders for prototypes from a foundry.

You don't have to transmit files to the Prototype Tapeout Service, however. You can lay out the chips yourself. The ChipBuilder package combines cell blocks into a complete IC layout and optimizes chip speed and size.

The fourth package, the Mentor Series, provides both block-compilation and custom-IC layout tools. The package runs on Mentor Graphics' (Beaverton, OR) CAE systems and uses that company's schematic-entry and logic-simulation software to generate cell blocks.

The Mentor Graphics software

runs on Apollo (Chelmsford, MA) workstations, but silicon compilation requires the memory and speed of a VAX. By using the Server package, you can enter a design on an Apollo workstation and run compilation and analysis programs on a VAX. This package gives every node on an Apollo-based network access to silicon compilation.

MacroCompiler, \$75,000; LogicDesigner, \$79,500; Mentor Series, \$159,500; Server, \$450. ChipBuilder depends on the host computer; eg, for a MicroVAX II, it costs \$119,000; for a VAX 8650, it costs \$295,000.

Silicon Compiler Systems Corp,
2045 Hamilton Ave, San Jose, CA
95125. Phone (408) 371-2900.

Circle No 584

An 80386 μ P and two operating systems enhance PC-compatible CAE workstations

CAE applications run two to three times as fast on the Personal Logician 386 as they do on the vendor's IBM PC/AT-based Personal Logician 286. The Personal Logician 286 uses Intel's 80286 μ P in its CPU; the Personal Logician 386 uses the 80386 μ P.

The system includes a 16-MHz 80386 μ P; 2.5M bytes of RAM; a 44M-byte hard-disk drive; an 80287 coprocessor; Enhanced Graphics Adapter (EGA) graphics; and a 13-in., 640 \times 350-pixel monitor. To improve your display, you can add a 15- or 19-in. color monitor. The optional monitors both spec 1024 \times 824-pixel resolution.

Because MS-DOS can address only 640k bytes of memory, the company's CAE and CAD software

doesn't run under MS-DOS. Instead, the design-automation programs run under DNIX (the company's implementation of Unix). This multitasking operating system features multiple display windows, expandable memory, and virtual memory.

The standard DNIX package includes a schematic editor, a design compiler, a text editor, and a netlist extraction program. You can add logic simulation, analog simulation, and test analysis. Other software available for the workstation includes layout tools for gate arrays, pc boards, and custom ICs. Note, however, that the 386-based PC can't run all of the company's software. You must transfer IC-layout-verification and pc-board-routing

tasks to a VAX or to the company's Logician computer.

The Logician, which also includes an 80386 μ P, runs all of the company's CAE and CAD programs, but doesn't run MS-DOS software. It features design and layout software; a 19-in., 1024 \times 832-pixel color monitor; a graphics controller; 85M bytes of hard-disk memory; and 4M bytes of RAM. You can expand the RAM to 16M bytes and the hard-disk memory to 1.2G bytes. Including IC-layout software, the Logician 386 costs \$85,000. The Personal Logician starts at \$20,000.

Daisy Systems Corp, Box 7006,
Mountain View, CA 94039. Phone
(415) 960-0123. TLX 858262.

Circle No 582

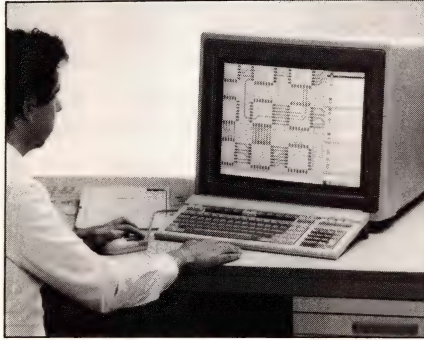
Computer-Aided Engineering

CAE workstation assists in all phases of electronic-equipment system design

Based on an HP 9000 Series 300 Unix computer, the IDS 4000 CAE workstation incorporates software modules to perform schematic capture, logic simulation, pc-board layout, and mechanical design. Each module is independent, allowing you to upgrade the system according to individual requirements.

In addition to providing standard symbols and components, the schematic-capture symbol library allows you to incorporate existing areas of your design as library modules. The system includes GenRad's Hi-Lo 3 simulation software.

The pc-board layout module copes with conventional or surface-mount component footprints, and allows you to add components at the layout stage with automatic modification of the net list. You are able to perform autorouting and interactive routing



of part or all of the design. You can also define vertical-clearance zones above and below the pc board with on-line checking so that components don't infringe on these height restrictions.

The mechanical-drafting module includes autodimensioning, filleting, and hatching functions, and it generates third-angle projection drawings from user-selected orthogonal views. In addition to the design

documentation, the IDS4000 CAE workstation generates output files suitable for use on various assembly and ATE.

To simplify use of the workstation, Unix commands and syntax are hidden behind a special user interface, which retains the security features of Unix, and also allows you to run third-party software written for a Unix environment. The price for a typical system ranges between £30,000 and £35,000.

Wayne Kerr Datum Ltd, Jenner Rd, Crawley, West Sussex RH10 2GA, UK. Phone (0293) 549011. TLX 87201.

Circle No 586

Wayne Kerr Inc, 600 W Cummings Park, Woburn, MA 01801. Phone (617) 938-8390. TLX 6817257.

Circle No 587

Library of voltage-vs-current functions accelerates analog-circuit simulation

By using an algorithm that interpolates parameters from electrical-data curves, the ACS circuit simulator can model devices four to 15 times as fast as Spice can. Furthermore, the simulator can model all analog devices—even ones that Spice must break into combinations of smaller components.

Simulations that use the Spice program require device models. The ACS package, however, simply extracts device parameters from measurements of electrical parameters.

To model an analog device with this simulator, you enter the current-vs-voltage, capacitance-vs-voltage, and inductance-vs-voltage functions of the device. Then, for

each applied voltage in a simulation, the program consults the electrical-data files and finds the state of the device. You can add electrical data to the simulator by performing measurements or by entering a graph. You can also use a Spice model.

The package's automodeler module translates device measurements into electrical-data files. To measure the capacitance, inductance, and resistance functions of a device, you must connect an HP 4145B or 4280 test system to the company's workstation.

You don't need to measure every analog device that you want to simulate; the vendor offers a library of standard devices. Each stand-

ard-device file provides three sets of performance characteristics: maximum, typical, and minimum. The library has typical resistors, capacitors, inductors, and diodes. It also includes bipolar junction transistors, junction FETs, MOSFETs, LEDs, and transformers.

ACS runs on the company's Interpro 32 (\$15,000) and 32C (\$25,000) workstations. The ACS automodeler and device-library modules each cost \$20,000; the simulator and the workbench modules each cost \$10,000.

Intergraph Corp, 1 Madison Industrial Park, Huntsville, AL 35807. Phone (205) 772-2000. TWX 810-726-2180.

Circle No 585

Computer-Aided Engineering

PC-board-manufacturing workstation integrates design, test, and fabrication

By transmitting the pc-board layout of a design to the CDX-60000S manufacturing workstation, you can adapt your design to fit your production requirements. Instead of stepping and repeating a photoplot, you step and repeat a layout on the workstation's screen.

Because pc-board manufacturers make boards in large panels, which contain many copies of one board, you can't use just one copy of a layout for production. You must step and repeat the layout across the panel.

The workstation's ability to process net-list data also lets it develop test vectors for production tests. Bare-board testers can use the files in the manufacturing workstation to simulate a complete panel. The system also creates complete bills of materials for panels.

The CDX-60000S can write fabri-



cation instructions for most production equipment, such as photoplotters, N/C drillers, profile routers, autoinsertion tools, and pick-and-place systems. If the manufacturing workstation can't write an instruction set for a particular fabrication system, you can use the workstation's database query language to create an instruction file for that system. Using the database query language, you can specify drill, shape, pad, via, insertion, and test instructions. The workstation

can then convert the instructions to any format.

You can enter design data from the vendor's CAD workstations or from Racal-Redac (Westford, MA), Scientific Calculations (Fishers, NY), and Computervision (Bedford, MA) systems. You can also enter photoplotter data, although you can't derive a net list from the graphical data that a photoplotter uses.

The CDX-60000S is a 68020-based color workstation. The system comes with 8M bytes of RAM (which you can increase to 12M bytes), the database query language, an asynchronous communications link, and a set of standard design postprocessors. \$119,900.

Cadnetix Corp, 5757 Central Ave, Boulder, CO 80301. Phone (303) 444-8075.

Circle No 583

Capture Your Imagination.

Introducing A New Standard In Schematic Capture Software For Engineering Professionals.

Imagine using a schematic capture program that's faster than any other. A program so powerful, it creates all objects in real-time. A program so simple, it uses a two-layer menu for less effort per edit. And a program so beautiful, it prints and plots with the clean, sharp, high-resolution results you want, everytime.

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Richardson, Texas 75081

On-site license available.

CIRCLE NO 45



SUN WORSHIP GOLDEN OF



WORSHIPPERS GET A PORTUNITY.

Like a beach in summer, Valid is drawing crowds of loyal Sun followers. And for good reason.

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Their NFS software allows any UNIX workstation onto the network transparently.

And no other EDA vendor offers better CAE, IC CAD and PCB CAD tools on UNIX than Valid.

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The logo for Valid, featuring a stylized 'V' symbol followed by the word 'VALID' in a bold, sans-serif font.



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Consider even better placement with automatic gate and component swapping. And better routing capabilities made possible by new routing algorithms; beveling

for 45°; and control of routing density across layered pairs.

Naturally, there's more to our story, such as support of surface mount devices. Including components on both sides of the board and buried vias.

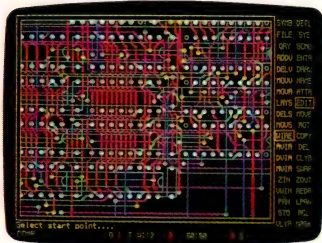
And there's still more big news. Like the performance to handle PCB designs of higher densities and non-standard sizes.

P-CAD's big capabilities also include improved graphics, drawing speed and text editing—all in a new system environment that's so easy to use even Mother Nature could appreciate it.

Which is why it's no surprise we're the market leader in PC-based PCB CAD. Nobody gives you this kind of performance at our prices!

So call (408) 971-1300 ext 7048 for information on the P-CAD dealers nearest you. Once you install Version 2.0, the most complex PCB designs become second nature.

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1290 Parkmoor Avenue
San Jose, CA 95126
(408) 971-1300

Computer-Aided Engineering

GATE-ARRAY DESIGN

Using the Gate Array WorkSystem, you can design a gate array even if you don't have layout experience. The software lets a logic designer control all phases of the gate-array design process, from schematic capture to physical layout. By combining foundry-endorsed layout algorithms with this vendor's TurnChip layout modules, the Gate Array WorkSystem lets you develop proprietary arrays in house.

Standard versions of the software cost \$70,000 and run on VAX II/GPX and Apollo 3000 workstations. TurnChip modules are available for three gate-array families: the 3900-gate C3900VH CMOS family from Fujitsu (\$3900), the 3500-gate Q3500S bipolar family from Advanced Micro Circuits Corp (\$3500), and the 2200-gate MPD65022 CMOS family from NEC (\$3500).

Tektronix CAE Systems Div., 5302 Betsy Ross Dr., Santa Clara, CA 95054. Phone (800) 547-1512; in CA, (408) 727-1234.

Circle No 390

UNIX LAB SYSTEM

The Scientific Laboratory System (SLS) features a 32-bit, proprietary memory bus that can transfer data between memory and the 68020 CPU at 12M bytes/sec max. A hardware bus adapter allows DMA data transfers between memory and a Multibus at 6M bytes/sec max. You can connect STD+Bus peripherals to the Multibus through a data-acquisition control processor that allows data transfers between the STD+Bus and the Multibus at 2M bytes/sec max. The memory-management unit provides each process with virtual addressing of 128M bytes max for system use and 128M bytes max for user space. An 8k-byte, write-through cache maintains no-wait-state performance by means of virtual addressing and direct mapping.

The SLS comes with a 650k-byte

floppy-disk drive and a 71M-byte hard-disk drive, both of which use the SCSI interface and transfer data at speeds as high as 1.5M bytes/sec over the SCSI bus. The built-in graphics hardware provides a resolution of 1152×910 pixels (monochrome) or 640×480 pixels (color). The system includes Laboratory Workbench, a menu-driven package that features pull-down menus, pop-up displays, icons, and interactive controls. From \$29,000.

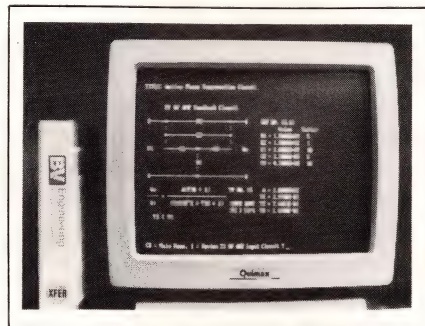
Masscomp, 1 Technology Park, Westford, MA 01886. Phone (617) 692-6200. TLX 704353.

Circle No 391

FUNCTION ANALYSIS

The XFER transfer-function analysis and synthesis program runs on IBM PCs and compatibles. Given an op-amp circuit configuration and the values of the circuit elements, the program computes the circuit's transfer function. Conversely, the program can use short-circuit transfer impedance functions around an op amp to compute the circuit configuration and element values that will synthesize a desired transfer function.

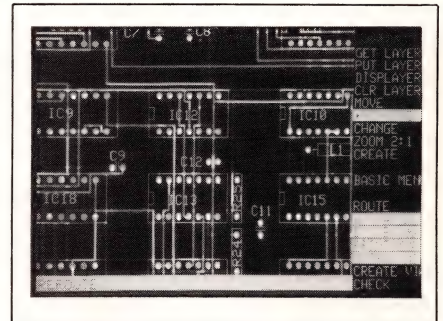
Because the program divides the forward and feedback elements of



op-amp configurations into multiple short-circuit transfer impedance functions, you can synthesize or analyze almost any transfer function that has real roots. The menu-driven program also computes the magnitude- and phase-response of a given circuit, and it allows you to perform sensitivity and Monte Carlo analyses. \$72.95.

BV Engineering, 2200 Business Way, Suite 207, Riverside, CA 92501. Phone (714) 781-0252.

Circle No 392



MULTILAYER CAE

EE Designer II provides all the functions of the earlier version for schematic capture, circuit simulation, and pc-board layout, but it employs a new graphics kernel and adds a variety of layout- and schematic-design enhancements. These enhancements include the ability to create ground planes on either side of a pc board and to display multilayer layouts. Layout enhancements allow you to define trace widths and pad sizes, to select both 5- and 12.5-mil grid spacing, and to perform block deletes, macro saves, and multistep pan. Schematic-capture enhancements include orthogonal rubberbanding.

The package comes with a starter library of surface-mount components, and the enhanced drawing package allows you to create new components and pad shapes. The library-management facilities include browse, fetch, and mirror operations. You can dump plotter files and numeric-control drill files to disk; you can also create generic plot files in ASCII format, containing absolute X and Y coordinates, which facilitate the writing of customized plotter driver routines. The program runs on IBM PC/XT, PC/AT, and compatible machines. \$1875.

Visionics Corp, 1284 Geneva Dr., Sunnyvale, CA 94089. Phone (408) 745-1551. TLX 346352.

Circle No 393

Computer-Aided Engineering

ASIC SIMULATOR

ZyPsim-AT is an ASIC-simulator package that runs on the IBM PC/AT and compatible machines. Its simulations of standard-cell networks take into consideration some characteristics of actual cell performance. By specifying the upper and lower limits of circuit operating conditions, you can adjust the timing within the cell modules for voltage, temperature, and processing effects. The simulator obtains its cell models from the vendor's standard-cell libraries and allows you to use the same regular, analog, cluster, and telescoping macros that you would use on the mainframe version (which runs on Prime computers). You specify the network, the cell list, the number of cells in the design, and the process technology to be used for fabrication, and the simulator then predicts the final die size of your ASIC chip.

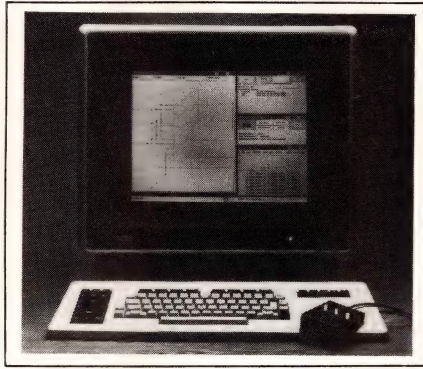
Because of the memory limitations of the PC/AT, you may have to divide a complex chip into sections and perform a preliminary simulation of each one separately. However, you can upload the sections to the vendor's mainframe to recombine the sections and perform a full simulation. \$2500.

ZyMOS Corp, 477 N Mathilda Ave, Sunnyvale, CA 94086. Phone (408) 730-5400.

Circle No 395

WORKSTATION

CoSim II is a simulation-accelerating computer that resides in an Apollo workstation network. It has a proprietary RISC architecture that simulates responses to a stream of data, representing real instructions, at rates as high as 5M gate evaluations per sec; you can simulate multiboard, multichip digital systems that have as many as 1M gates. The accelerator forms part of the AIDA design system, which uses both software constructs and hardware coprocessors to achieve a level of performance that, according



to the vendor, was previously impossible on mainframe-based CAE systems. \$85,000.

Aida Corp, 3375 Scott Blvd, Suite 340, Santa Clara, CA 95054. Phone (408) 748-8571.

Circle No 394

ASIC TOOLS

Symbol libraries and design tools for LSI Logic's ASICs are now available on Cadnetix workstations. The libraries include the vendor's LL5000, LL7000, and LL9000 Series HCMOS array libraries; the tools include pre- and post-layout back-annotation of gate and interconnect delays, as well as manufacturing interfaces to an LSI Logic Design Center. During the schematic-capture phase of design, you work with macrocell libraries certified by LSI Logic. You can simulate the circuit first with unit delays and then with estimated delays incorporated, after which you send the design to an LSI Logic Design Center for physical layout. The symbol library and net-list components of the package reside on a 68020-based server; a PC can access them via the network. \$25,000.

Cadnetix Corp, 5757 Central Ave, Boulder, CO 80301. Phone (303) 444-8075.

Circle No 397

COMPILER

The ASN.1 compiler is based on CCITT standard X.409; it accepts protocol data units (PDUs) defined in ASN.1 (Abstract Syntax Nota-

tion One) and generates the corresponding C language structures for manipulation by upper-layer protocols. Thus, in developing an application program, you don't have to re-code the PDUs manually from the complex ASN.1 syntax. The compiler is particularly valuable when you're upgrading ISO application- and presentation-layer protocols to conform to the MAP (manufacturing automation protocol) 3.0 and TOP (technical and office protocol) 3.0 standards.

The compiler is available only as part of the vendor's ISO Upper Layer Protocol package, which includes C source code for the File Transfer and Management and Common Application Services Elements kernel application-layer protocols. License fee, \$19,750; per-copy royalties are additional; current licensees of either package will receive the compiler at no charge.

Communication Machinery Corp, 1421 State St, Santa Barbara, CA 93101. Phone (805) 963-9471.

Circle No 396

TEST GENERATOR

The ATG-32 software package, which runs on the vendor's 3200V computer system as well as on most VAX and MicroVAX machines, allows you to develop test programs to run on the vendor's 227X family of in-circuit automated-test equipment. The menu-driven interface controls and directs your access to various utilities, both automatic and interactive, which can generate test programs for use on 227X systems. By making use of the VAX's large physical memory and its virtual-memory facilities, the package can generate programs to test boards containing complex VLSI devices and ASICs. From \$30,000.

GenRad Inc, 300 Baker Ave, Concord, MA 01742. Phone (617) 369-4400.

Circle No 420

Computer-Aided Engineering

DSP DEVELOPMENT

The DSP-320 development system consists of three components: the vendor's DSP-D digital board, which loads and runs programs on the Texas Instruments TMS32010 digital signal processor; the DSP-A analog board, which provides A/D and D/A peripheral interfaces for the TMS32010 processor; and the vendor's ASM-10 assembler, which lets you develop TMS32010 programs on an IBM PC or compatible and then download them to the DSP-D board for execution.

The DSP-D board consists of a TMS32010 running at 20 MHz; an 8039 μ C for local control of the TMS32010 and RAM; as much as 4k bytes of RAM for program storage; and ROM-resident firmware for communication with a video terminal or with an IBM PC via an RS-232C port. Using the 40-pin header included in the package, you can connect the DSP-A analog subsystem, which provides 8-bit A/D and D/A converters, jumper-selectable sampling-clock rates as high as 20 kHz, and analog filters for antialiasing and reconstruction of analog signals. Written in C, the assembler runs on an IBM PC or compatible. DSP-D, \$299; DSP-A, \$199; ASM-10, \$129.

Microcraft Corp, Box 513, Thiensville, WI 53092. Phone (414) 241-8144.

Circle No 400

PC-BOARD DESIGN

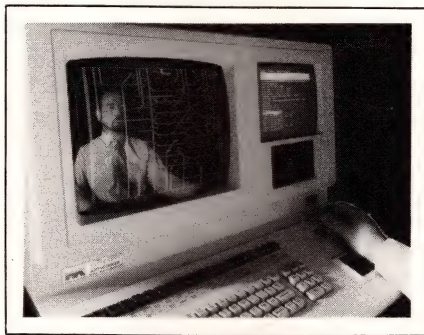
Enhancement options for the Apollo DN3000 workstation allow it to run this company's PCB Worksystem CAE software. These enhancements include an increase in main memory to 4M bytes and in disk storage to 155M bytes. The PCB Worksystem offers schematic capture, board layout, and, in conjunction with the Tektronix Hilo-3, simulation of large logic systems. The software offers both automatic and interactive placement of parts, either on the whole board or on specif-

ic areas. You can use various routing strategies, singly or in combination, when making multiple passes to optimize board layout.

A workstation consisting of the Apollo DN3000, 4M bytes of memory, 155M bytes of disk storage, a keyboard, a mouse, dual operating systems (Unix 4.2BSD and Apollo Aegis), and Tektronix pc-board design and layout software configured for the DN3000 costs \$49,900.

Tektronix Inc, CAE Systems Div, 5302 Betsy Ross Dr, Santa Clara, CA 95054. Phone (800) 547-1512; in OR, (800) 542-1877; in CA (408) 727-1234.

Circle No 402



PC-BOARD CAD

Enhancements to the Artworker 3000 pc-board CAD system increase its overall speed by as much as 20% and add high-speed zoom, pan, and scroll facilities. You can zoom in or out of a layout using as many as four different predefined magnification factors. Additional enhancements include a 100% speed improvement in the autorouting operation, with some improvement in the quality of the routing. The system allows you to generate schematics incorporating as many as 10 100 \times 100-in. sheets, and to perform interactive placement. The system includes all necessary hardware and software; prices for the enhanced Artworker 3000 start at approximately £12,000.

Wayne Kerr Datum Ltd, Jenner Rd, Crawley, West Sussex RH10 2GA, UK. Phone (0293) 549011. TLX 87201.

Circle No 403

SOURCE CODE

The source code for MTBasic, the Basic compiler that has become a de facto standard for complex process-control applications, is available for purchase. The compiler generates fast-executing code suitable for real-time, multitasking applications; it contains statements and functions that facilitate the manipulation of various sensors and other process-control I/O devices. The compiler also provides task-execution and -sequencing statements that let you run as many as 10 concurrent tasks.

Availability of the source code lets you reduce the size of the compiler that fits into a ROM by, for example, removing the windowing functions. You can also add statements and functions of your own to handle application-specific I/O devices. You have a choice of three versions: one for Z80 systems; one for 8088 systems; and one for HD64180 systems. Each version costs \$5500.

Softaid Inc, 8930 Rte 108, Columbia, MD 21045. Phone (800) 433-8812; in MD, (301) 964-8455.

Circle No 401

CAE WORKSTATION

The HP Series 9000 Model 350, available in six configurations, is based on the 25-MHz 68020 μ P, supplemented by the 20-MHz 68881 numeric coprocessor. All configurations come with a 32k-byte, write-through cache that operates with no wait states; 8M bytes of RAM (expandable to 32M bytes); HP-IB (IEEE-488) and RS-232C interfaces; a high-speed disk interface; and a LAN interface conforming to the IEEE 802.3 standard. Configurations include a keyboard, a display, a mouse, and all necessary cabling. The operating system is HP-UX, the vendor's implementation of Unix.

At the low end of the line is the 350SPU, a stand-alone unit that can act as a network server or multiuser

Computer-Aided Engineering

processor. At the other end is the 350SRX workstation, which provides a graphics resolution of 1280×1024 pixels and is equipped with a 19-in. color display that can have as many as 24 color planes. The 350SRX is capable of executing complex applications such as 3-D mechanical design, molecular modeling, solids modeling, geophysical engineering, and earth-strata analysis. Prices range from \$21,900 to \$54,900.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 405

COMMUNICATIONS

Blast-Host runs under IBM's VM/CMS and MVS/TSO operating systems and uses any asynchronous pathways typically found in the mainframe environment to provide file-transfer facilities between the mainframe and a minicomputer or a microcomputer such as a Macintosh or an IBM PC. According to the vendor, the proprietary transmission protocol provides high-speed, error-free communication over diverse media such as X.25 packet-switched networks, satellite links, and noisy telephone lines. With the addition of a protocol converter, the program can emulate a 3270 terminal. Blast-Host for IBM mainframes, \$5500; Blast for minicomputers, \$495 to \$1295; Blast for IBM PC or Macintosh, \$250.

Communications Research Group, 5615 Corporate Blvd, Baton Rouge, LA 70808. Phone (504) 923-0888. TLX 759985.

Circle No 407

MICROCODE TOOL

Version 1.10 of the Hale Macro-Meta-Assembler for microcode includes substantial enhancements. The pipeline macros let you assign any microcode field; you can string together existing source macros to create microcode or to create a high-



er-level macro. You can operate as many as eight pipeline macros simultaneously. The software lets you define errors, so you can assert microprogram design rules; the assembler checks your code against these rules and warns you of any violations. You can insert nonassembling messages at any point in the source code to trace assembly-program flow or to indicate untested routines. The While and Endwhile looping directives allow the assembler to generate code from statements placed between these directives as long as a user-specified condition remains true.

An ASCII code-conversion feature lets you code data in ASCII format. When you invoke the feature, it converts the data to binary form for embedding within the microcode. Thus, when you want to use the same message in different parts of your system, you need only enter it once in ASCII format and then invoke the converter at each occurrence of the message. Relocatable version for the IBM PC, \$2300; relocatable versions for VAX, Sun, and Apollo computers, \$3500.

Hilevel Technology Inc, 18902 Bardeen, Irvine, CA 92715. Phone (714) 752-5215.

Circle No 404

VLSI ANALYSIS

Meta-Shmoo is an enhancement of the operating software of the vendor's Topaz design-verification systems for VLSI devices. It lets you automatically plot the performance of a device by means of a Shmoo

(safe modes of operation) plot. You can plot time vs voltage, time vs time, voltage vs time, or voltage vs voltage, both for thorough characterization of a device and for automatic measurement of parameters, such as propagation and setup times. The program lets you select the parameters to be plotted, the pins on which the system will take measurements, maximum and minimum test values, and incremental values at which tests are to be conducted.

You can display the test results on the screen or output them to a dot-matrix printer. During operation, the Topaz system runs the entire vector set at each incremental point on the plot, thereby allowing the program to display the worst-case pass/fail condition for each set of Shmoo parameters. \$2500.

HiLevel Technology Inc, 18902 Bardeen, Irvine, CA 92715. Phone (800) 445-3835; in CA, (714) 752-5215. TLX 655316.

Circle No 406

CAE WORKSTATION

The Conceptstation consists of an IBM PC/AT enhanced by a proprietary 32-bit, 8M-flops accelerator coprocessor and graphics subsystem. You can run MS-DOS software, such as productivity and software-development tools, on the PC/AT. The vendor's MCAE software, written in C, runs under Xenix and makes use of the accelerator coprocessor to achieve maximum analysis and display speed. The MCAE software includes a geometric modeler that generates solid, surface, or wire-frame images; a finite-element modeler; a design-rule processor; a materials-property manager program; and a macrodesign language.

The workstation is available in two versions. The bundled version includes a PC/AT; a 1.2M-byte floppy-disk drive; a 9.2M-byte RAM; a 60M-byte hard disk; an Intel 80287 math coprocessor; a 3-button optical mouse; a 256-color, 1024×770-pixel

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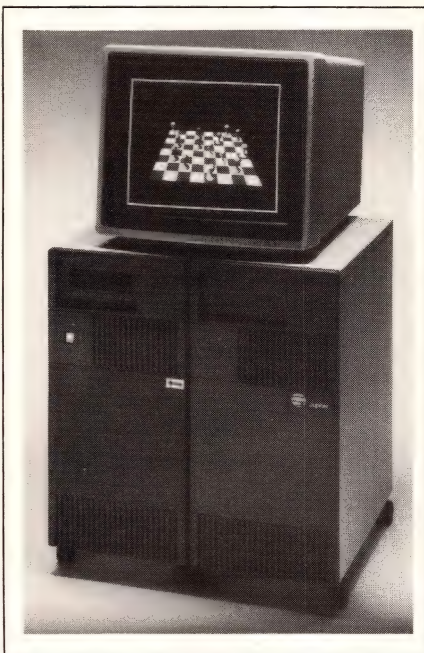
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Computer-Aided Engineering

monitor; and the vendor's proprietary accelerator and graphics hardware, together with MCAE, Xenix, and MS-DOS. The unbundled version includes all of the proprietary items, but you have to provide your own PC/AT and 60M-byte hard disk. Bundled version, \$49,000; unbundled, \$36,500.

Aries Technology Inc., 650 Suffolk St., Lowell, MA 01854. Phone (617) 453-5310.

Circle No 409



GRAPHICS SUBSYSTEM

The Satellite is a high-resolution color-graphics display subsystem for use with Sun Microsystems (Mountain View, CA) workstations. Available in several configurations, all units feature a resolution of 1280×1024 pixels and a palette of 16 million colors; the frame buffer can have as many as 28 bit planes of image memory per pixel. Features include one to four independent color-display channels, programmable video-display formats, and a user-programmable, writable control store. The design of the frame buffer allows you to update it during display operations, and double buffering facilitates hidden-redraw operations. The unit provides both 4-

and 8-bit color-lookup tables, as well as 12- and 24-bit RGB modes.

The system comes with two libraries of graphics functions: The Basic Graphics Library (BGL) provides the machine-control functions and 2-D graphics functions defined in device coordinates; the High-Level Graphics Library (HGL) provides hierarchical display lists with 3-D functions in a world-coordinate space. The monitor screen can be 16 or 19 in.; both sizes have a scan rate of 65 kHz and a bandwidth of 110 MHz. \$15,000 to \$30,000. Delivery, 30 to 45 days ARO.

Jupiter Systems, 1100 Marina Village Parkway, Alameda, CA 94501. Phone (415) 523-9000. TLX 6713004.

Circle No 408

OPERATING SYSTEM

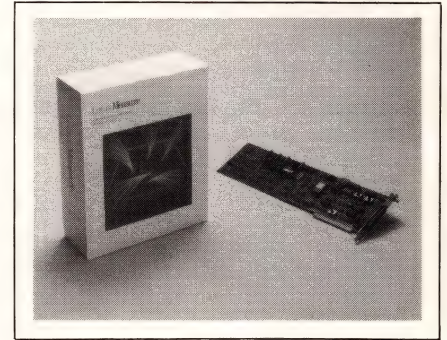
The SK-11 is the kernel of an operating system for the 68HC11 controller-on-a-chip. It resides in EPROM and occupies less than 4k bytes. To develop a real-time process-control application, you edit the predefined shell (included in the package), setting up a control block that defines how the kernel is to access your initialization, background, and interrupt-servicing routines. You can download data for development in RAM. The kernel has utility routines for double-precision multiplication, EEPROM erasure and reprogramming, and serial communication. The built-in commands can erase an EEPROM in bulk, cold-start the kernel software, execute your applications code, download S-records, and display help screens. You can add other commands to the kernel.

The package consists of a diskette in IBM PC format that contains source code for both the 68HC11 kernel and the user-program shell, one 2764 EPROM containing the kernel object code and another containing object code for a sample user-program shell, and a user's manual that includes SK-11 soft-

ware listings. \$125.

Allen Systems, 2151 Fairfax Rd., Columbus, OH 43221. Phone (614) 488-7122.

Circle No 411



DATA ACQUISITION

Measure is a software package for personal computers that lets you acquire data via the Metrabyte (Taunton, MA) DAS-16 and DAS-16F boards and store the values directly in the vendor's 1-2-3 spreadsheet. You can use the spreadsheet's math and graphics functions to reduce, analyze, and display the data. When installed, the program becomes part of 1-2-3; you can bring up the data-acquisition menus by pressing the Alt and F8 keys concurrently (these menus are similar in format to those of the spreadsheet). You can acquire as many as 64 channels of incoming data simultaneously at a maximum rate of 3000 samples/sec, and the program automatically converts the values to engineering units. You can display as many as 16 channels in real time. The program can also acquire data from more than 8000 types of instruments via an RS-232C or IEEE-488 interface.

Measure runs on the IBM PC, PC/XT, and PC/AT; the Hewlett-Packard Vectra PC; and the Compaq Portable. It requires 512k bytes of memory and runs under MS-DOS 2.0 or higher and Lotus 1-2-3 2.0 or higher. \$495.

Lotus Development Corp., 55 Cambridge Parkway, Cambridge, MA 02142. Phone (617) 577-8500.

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FILTER DESIGNER

Active Filter Design version 2.10 prompts you to specify a frequency response; it then presents a menu of filter types that will produce this response. For each type (Butterworth, Chebyshev, elliptic, and Bessel), the program shows the required filter order and the stopband attenuation. In addition, you can enter pole and zero locations, or a transfer function, from the keyboard and instruct the program to generate the desired filter configuration from that data. The software works with manual or automatic pole-zero pairings, as well as with uneven gain distribution. You can store the data in a disk file for later analysis or modification.

A companion program converts the circuit file created by the design package to a Spice-compatible net list. Both programs run on IBM PC-family and compatible computers with at least 350k bytes of RAM and PC-DOS 2.0 (or later). The programs can use an 8087 numeric coprocessor. Design package, \$525; Spice file-conversion program, \$125; both, \$625.

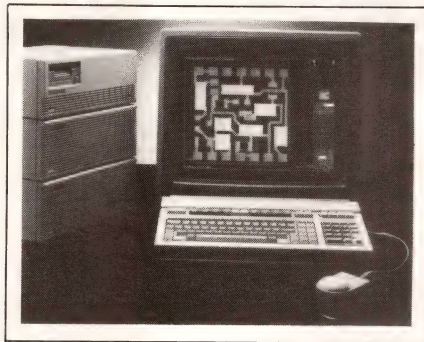
RLM Research, Box 3630, Boulder, CO 80307. Phone (303) 499-7566.

Circle No 412

HYBRID-CIRCUIT CAE

This hybrid-circuit design module for thick-film circuits is a CAD module that runs with the vendor's Engineering Graphics System. It can operate in conjunction with other modules of the company's Electronic Design System. All modules run on HP 9000 Series 200 and 300 workstations. The software's automatic and interactive features include automatic thick-film-resistor generation; a starter library containing more than 300 hybrid parts and subparts; and the ability to work with irregularly shaped conductors and to add dielectric crossovers.

Using the editing features, you can move, rotate, stretch, or mirror



parts or conductors on a grid that provides a resolution of 0.00001 mil; placement-snapping modes ensure that the parts and conductors are precisely placed. You can vary the width of the conductors; system messages help you to route multilayer conductors. You can also generate a connection list from your completed layout. A connection-list comparison program ensures that this list agrees with the list generated by the schematic-drawing module. Design module, \$4000; engineering-graphics module, \$6000; optional schematic-drawing module, \$1000.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 414

CAE NETWORK

Dash-Net allows engineers working on a common project to share central design libraries and databases and to communicate with VAXs that use the TCP/IP protocol. The network is compatible with the company's CAE tools and has three main components: the DN3-Server, which serves as many as 25 workstations and includes a 70M-byte disk, 960k bytes of memory, and a 60M-byte cartridge-tape-backup unit; the DN-Station Ethernet board and network at each node; and DN-CABL Ethernet cable. DN3-Server, \$11,950; DN-Station hardware and software, \$650 per node; DN-CABL, \$45 (7m) to \$200 (100m).

FutureNet, 9310 Topanga Canyon Blvd, Chatsworth, CA 91311.

Phone (818) 700-0691. TWX 910-494-2681.

Circle No 413

SILICON COMPILER

The ASA compiler accepts circuit definitions in a hardware description language, OLA, and contains all the necessary software modules to generate PG tapes for wafer fabrication. OLA is a high-level Pascal-like language that allows you to describe both functional and structural requirements. It supports both parallel and sequential processing constructs and finite state-machine descriptions. A logic simulator allows you to check the hardware description at both the functional and logical level.

A layout generator provides automatic or interactive floorplanning and routing. Initially, the layout generator places circuit modules to minimize the total chip area and to establish interconnect pathways between the modules. A second layout stage assembles the modules themselves and establishes supply interconnections. The compiler runs on VAXs operating under VMS, and requires Tektronix-4107 or -4207 and upwardly compatible graphics terminals. \$50,000 to \$80,000.

Sagantec BV, Croy 5a, 5653 LC Eindhoven, The Netherlands. Phone (040) 521175. TLX 59163.

Circle No 423

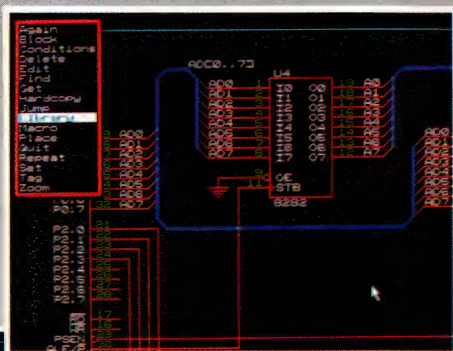
PC-BOARD CAD

KAD-286 is a CAD workstation that allows you to perform schematic capture, simulation, and layout generation for pc-board or hybrid component designs. It consists of the company's IBM PC/AT-compatible computer equipped with a 1024×780-pixel resolution graphics board, either a 20-in. color or 17-in. monochrome monitor, and an 11×11-in. digitizing tablet. You can organize schematics into as many as 200 pages and produce single-page or global net lists and component

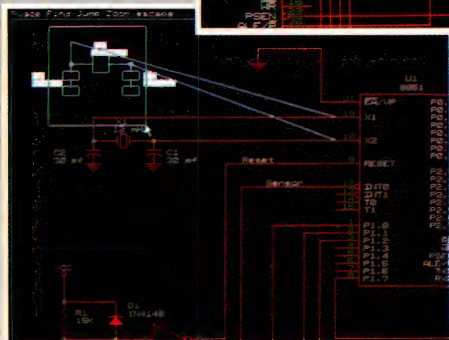
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listings from them. You can modify net lists during the simulation or routing phases.

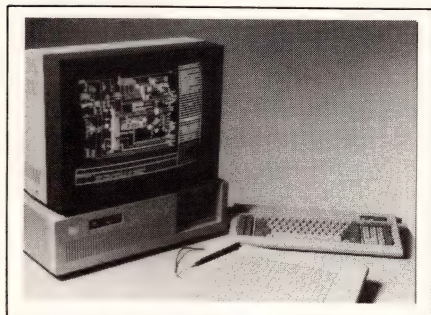
Post-layout processing allows you to perform design-rule checks and to compare and verify layout and schematic net lists. Post-layout software is available, including drill-tape generation and plotting on pen, photo, impact, laser, or thermal plotters. Around DM 40,000. The software is available separately.

Kontron Messtechnik, Oskar-von-Miller-Strasse 1, 8057 Eching/Munich, West Germany. Phone (08165) 77551. TLX 526719.

Circle No 424

Kontron Electronic Inc, 633 Clyde Ave, Mountain View, CA 94039. Phone (415) 965-7020. TWX 910-378-5207.

Circle No 425



SCHEMATIC CAD

Interfacing to most circuit simulators and routers, the ESP schematic capture software allows you to create analog or digital circuit designs on an IBM PC or compatible. The menu-driven program has a user-definable symbol menu that allows you to enter your own symbols into the symbol library.

Editing facilities include a check on the revision status of symbols, symbol updating, cell movement and alignment, automatic text location, and labeling. In addition, the system's net-list extraction routines verify signal integrity between both circuit blocks and schematic sheets. The system handles multisheet drawings and includes pan and zoom facilities. A macro facility allows you to build your own commands, and

the "journaling function" allows for crash recovery or procedure duplication. Around £5000 for a single-user license.

Cocad Ltd, Ashford House, Tuf-ton Centre, Ashford, Kent TN23 1YB, UK. Phone (0233) 43445. TLX 966444.

Circle No 426

GATE-ARRAY CAD

Running on an IBM PC, PC/XT, PC/AT, or compatible computer with 640k bytes of memory and an EGA board and monitor, the Gate Aid Plus/PC software allows you to use the company's MA Series of 3- μ m, single-layer-metal gate arrays. The software includes schematic-capture, gate-level simulation, testability-analysis, and fault-simulation capabilities. It also includes a PLD converter package that allows you to integrate several programmable logic arrays into one ASIC. Less than \$15,000.

Matra-Harris Semiconducteurs, Les Quadrants, 3 avenue du Centre, 78182 Saint Quentin en Yvelines, France. Phone (1) 30438272. TLX 697317.

Circle No 398

Matra Design Semiconductor, 2840-100 San Thomas Expressway, Santa Clara, CA 95051. Phone (408) 986-9000.

Circle No 399

ACCELERATOR

PerSim is a hardware-software coprocessor contained on a board that uses the IBM PC/AT bus and plugs into an Apollo DN3000 workstation. The coprocessor consists of a proprietary RISC (reduced-instruction-set computer) that accelerates the execution of the vendor's Logic- and Fault-Simulation design tools. Two models are available. Model I can simulate as many as 64,000 gates and perform 1 million gate evaluations/sec. Model II can simulate as many as 128,000 gates and perform 2.5 million gate evaluations/sec.

Model I, \$7500; Model II, \$20,000.

Aida Corp, 3375 Scott Blvd, Suite 342, Santa Clara, CA 95054. Phone (408) 748-8571.

Circle No 417

PC-BOARD DESIGN

The Board Series consists of four programs that let you design and route high-density, multilayer pc boards containing blind and buried vias. You can also use one power plane for two or more voltages and embed signal traces within a given power plane. A net-list interface lets you pass net-list information from another CAE system to this software for layout and routing; you can then pass pin numbers, reference designations, and similar information back to the CAE system for back-annotation and documentation.

The packages run on Apollo DN570, DN3000, or DN3000+ workstations and have different capabilities to suit different applications. Designer provides full design capabilities, including schematic capture, packaging and pin assignment, autoplacement, interactive and automatic routing, simulation, and CAM capability. Editor Plus has the same design and layout features, but doesn't include routing or CAM features. Scribe performs only schematic capture and packaging. Editor and Scribe are intended for use as low-cost nodes on an Apollo DN3000 that's linked to another workstation running Designer. Expeditor is a high-performance routing package that provides CAM features but needs to be linked to Designer for full design capability. \$30,000 to \$90,000.

Calma Co, 501 Sycamore Dr, Milpitas, CA 95035. Phone (408) 434-4000. TLX 3720067.

Circle No 416

THINK...

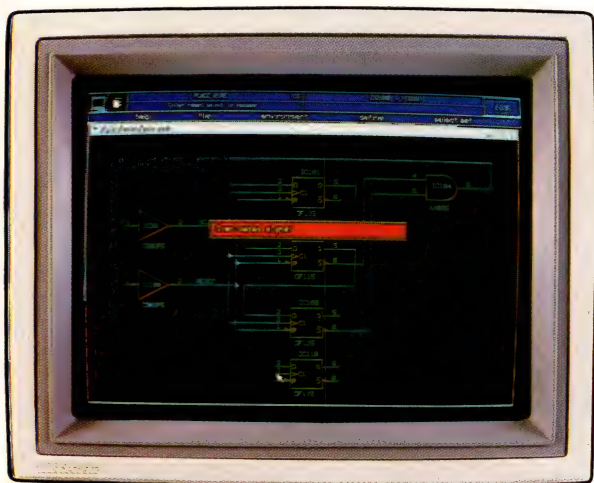


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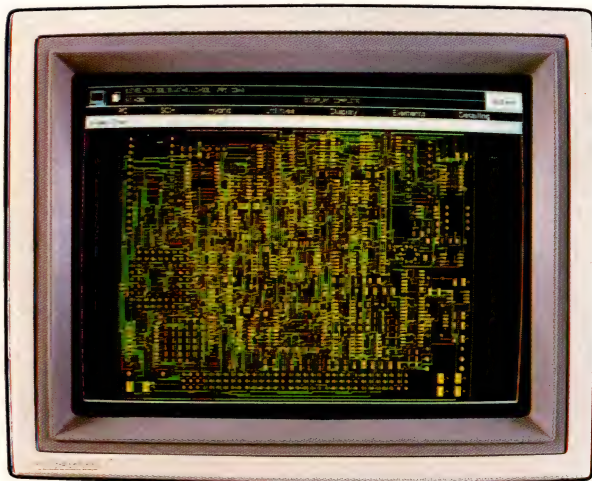
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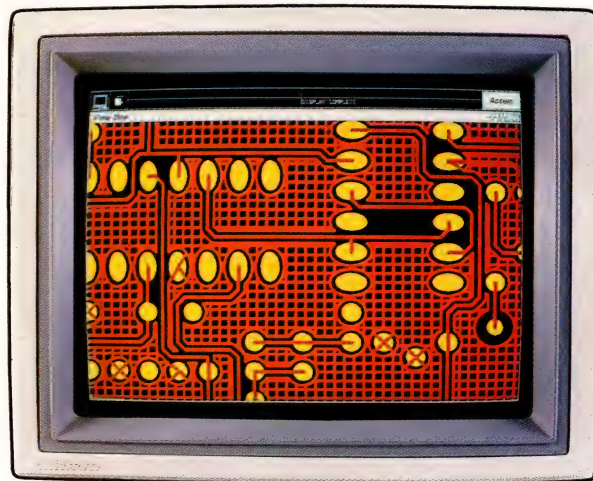
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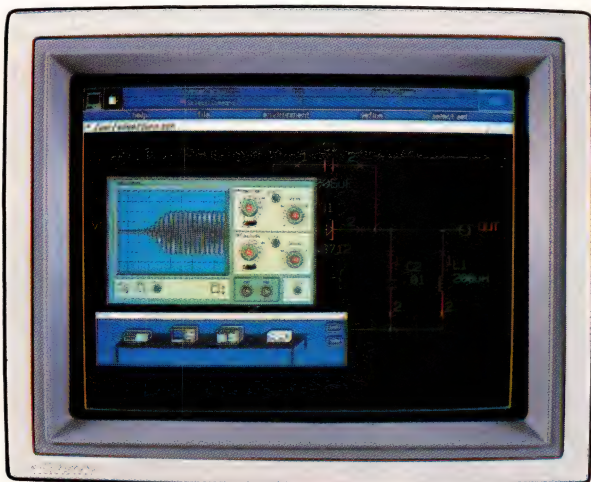
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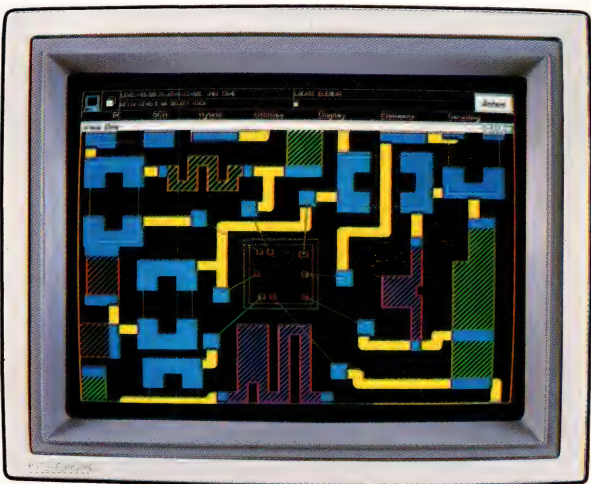
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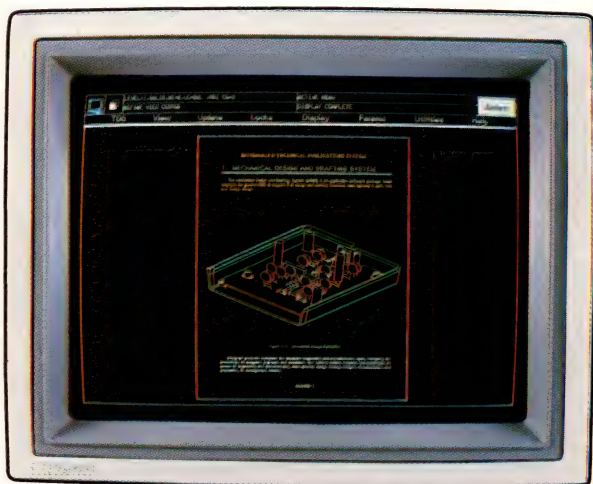
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INTERGRAPH

Although the basic job of in-circuit emulators has not changed, the complexity of the microprocessors they emulate has. Nevertheless, many emulators can deal with the high-level languages and at the fast clock speeds of today's μ Ps.

Chris Everett, *Regional Editor*

The increasing levels of integration and the rising clock speeds of 16- and 32-bit microprocessors have made their emulators' jobs difficult, but many emulators are up to the task. The fundamental use of an emulator—its duplication of the operation of the microprocessor chip it replaces—remains the same. But now, emulators must duplicate the operation of the DMA-controller, memory-management, and dynamic-RAM-refresh circuitry that often resides on μ P chips. Furthermore, speed, always an issue with emulators, is becoming a critical factor: Some of today's μ Ps have clock rates higher than 20 MHz. Emulators are catching up, however, and some can emulate the most popular μ Ps at their maximum clock rates. What's more, they can handle the complex programs, written in languages like C and Pascal, that designers are now producing.



Fully integrated systems for developing and debugging hardware and software have always been available. Yet the high cost of these special-purpose systems simply encouraged some users to assemble their own systems by hooking an emulator to whatever mainframe or personal computer they used. On the other hand, today's high-level software and 32-bit processing demand a sophisticated debugger that works with both the in-circuit emulator and the output of the compiler. As a result, the μ P-development-system makers are now selling versions of their software that run on PCs and VAXs, and the makers of stand-alone emulators now offer integrated packages composed of compilers, debuggers, and emulators.

Manufacturers are responding in various ways. Motorola, for example, has ceased production of the Exor-max and Versa development systems in favor of the PC-based HDS development system. And Tektronix has introduced a VAX-based 32-bit processor develop-

In-circuit emulators keep pace with 16- and 32-bit μ Ps



16.67-MHz 68020 in-circuit emulator (Applied Microsystems)

ment system. Intel is using its Opennet local-area network to connect VAXs, PCs, and dedicated development systems together, and Hewlett-Packard sells a μ P-development system that operates in a Unix environment.

Third parties offer PC links

All of the third-party in-circuit-emulator suppliers now offer their products with communication links to PCs. These communications programs simply allow you to access an in-circuit emulator's built-in commands for machine-code debugging. Even a low-cost emulator like Nicolet's \$1950 model for the 68010 μ P has a link and can interface with several compilers and crossassemblers supplied by third parties. Huntsville Microsystems links its 8086 family (\$2795 to \$2995) and 68000 family (\$7500 to \$9750) of emulators to Unix-based computers as well as to PCs.

In addition to providing simple communication pro-

grams, Huntsville Microsystems is one of several third-party in-circuit-emulator suppliers who offer both high-level software-development and debugging tools along with their emulators. Microcosm has a \$3500 source-level debug tool that's compatible with its ECU Series in-circuit emulators. It provides full symbolic source-level debugging for the Microtec Research 68000/10 C compiler. You can control and monitor program execution by C source lines. You can also refer to memory locations by C variables and expressions. The debugger runs on a PC, a VAX, or an Apollo or Sun workstation.

Applied Microsystems also offers a wide range of software development and debug tools from a number of vendors, allowing you to build your own microprocessor-development system using your choice of hosts and of software and hardware development tools. Within the company's family of development tools, you have a choice of Concurrent Sciences, Microtec Research, and Intermetrics software development tools that run on an



Microprocessor development system with 16-bit in-circuit emulator
(American Automation)

IBM PC, PC/XT, PC/AT, VAX, MicroVAX, or a Sun or Apollo workstation.

Although 16-bit microprocessors have been available for years, corresponding in-circuit emulators capable of duplicating their full-speed operation have been slower to appear. But the speed gap is closing. Applied Microsystems recently announced that its 8088 and Z8000 emulators can run at 10 MHz and that its 68000 and 68010 emulators can run at 12.5 MHz. You can upgrade an existing Applied Microsystems emulator for approximately \$3600; prices for the latest version begin at \$10,495.

For the 80286 processor, Hewlett-Packard has a \$9400 8-MHz emulator that supports both the real-address and protected virtual-address modes. You can order as much as 1M bytes of emulation memory, mappable in 4k-byte increments anywhere in the 80286's 16M-byte physical-address space.

You can order either an \$11,995 8-MHz probe or a \$13,495 10-MHz probe for Intel's 80286 emulator. Either emulator can have as much as 288k bytes of emulation memory. Trace memory is 1023 cycles deep.

Applied Microsystems' \$11,495 80286 in-circuit emulator operates to 12.5 MHz. It also supports both the real-address and protected virtual-address modes. You can order as much as 512k bytes of emulation memory. The emulator's trace memory is 72 bits wide by 2046 cycles deep.

Two emulators available for 80386 debugging

Intel's 32-bit 80386 μ P has not yet spawned a wide choice of emulators. Just two in-circuit emulators are currently available: Intel's own \$15,000 ICE-386 and Microtek's \$17,000 Mice-32/80386. When operated according to certain restrictions, both units can emulate as fast as 16 MHz.

To operate at the 16-MHz rate, the Intel emulator requires that the target system use its own memory

and be able to run without using the optional isolation board. That board protects the emulator from electrical damage caused by your target system. You don't need it if you can guarantee that a bus controller drives the data bus only during valid read cycles of the 80386 or while the processor is in the hold state. If you must use the optional isolation board, the maximum emulation speed slows to 8 MHz.

The penalty for using Intel's emulation memory is, on average, six wait states. The 80386 microprocessor can address 4G bytes of memory. Intel's ICE-386 can map 128k bytes anywhere within this 4G-byte region in 4k-byte increments on 4k-byte boundaries. If you decide to use the mapped memory during emulation, however, you cannot use the processor's paging mode because both functions share the same resources on the 80386.

Buffer stores 2000 frames of program execution

You can set four on-chip breakpoints in the ICE-386 to halt your program at specific execution addresses or data accesses. An execution-address trace buffer stores more than 2000 frames of program execution history. In addition, you can interrogate and modify processor objects and system memory. The emulator supports both the 80286 and 80386 coprocessors and features



20-MHz 68020 in-circuit emulator (Atron)

symbolic debugging for Intel's C compiler. During debugging, the ICE-386 maintains a virtual table of the program symbols. (Because it's a virtual table, it does not need to fit entirely into the host's RAM memory.)

You can use this emulator with an Intel 286/310 system with 2M bytes of RAM, a 40M-byte hard-disk drive, at least one floppy-disk drive, and the Xenix 286 operating system. Or you can use it with an IBM PC/AT with 2M bytes of RAM, a 20M-byte hard-disk drive, at least one floppy-disk drive, a serial interface, and the

Not only must emulators duplicate more of the operation of your design during debugging, but they must do it at higher clock rates.



Unix-based microprocessor development system with 68020 in-circuit emulator (Hewlett-Packard)

DOS operating system. (For faster uploading and downloading of data, Intel recommends that you order the GPIB interface for the PC.)

Use either a parallel or serial interface

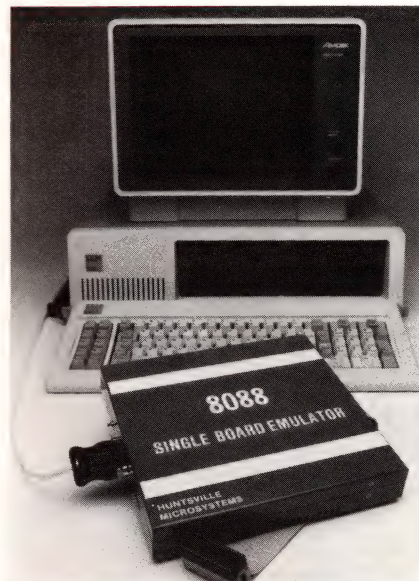
Microtek's Mice-32/80386 in-circuit emulator can work with an IBM PC/XT or PC/AT and with a VAX or a MicroVAX via either a parallel or serial interface. It can operate to 12.5 MHz with no wait states if you use its emulation memory during emulation. If you use just the target system's memory, then the emulator can operate at 16 MHz without wait states. You can use as much as 256k bytes of emulation memory with the Mice-32/80386 in-circuit emulator, but you can only break the emulation memory down into four 64k-byte increments for mapping.

Like the Intel ICE-386 emulator, the Mice-32/80386 in-circuit emulator lets you trace more than 2000 events. Each recorded event is 104 bits wide (32-bit address, 32-bit data, 8-bit status, 8-bit external trace, and 24-bit timer). The 24-bit timer measures the execution time for each cycle at a resolution of 1 μ sec to 10 msec.

The Mice-32/80386 in-circuit emulator has five hardware breakpoints. You can base two breakpoints on events on the microprocessor's bus. You can set two other breakpoints in relation to program operation. In this way, you can break emulation at the program boundary for any memory type—ROM, RAM, target memory, or emulation memory. The fifth breakpoint is external.

68020 emulators are in the race

In contrast to the Intel 80386's choice of two emulators, Motorola's 32-bit processor, the 68020, is supported by Motorola itself and by a number of third parties. Applied Microsystems was the first after Motorola to offer a 68020 emulator. Initially, its emulator was spec'd to operate to 12.5 MHz. Last February, Applied Microsystems increased the emulation speed to 16.7 MHz. The company also improved several of the



PC driven 8088 in-circuit emulator (Huntsville Microsystems)

emulator's features: The trace memory width grew from 72 to 101 bits; the trace disassembler was redesigned to handle 8-, 16-, and 32-bit-wide traces; a time-stamp capability became standard; and software was added for searching the raw trace data for address, data, or status information.

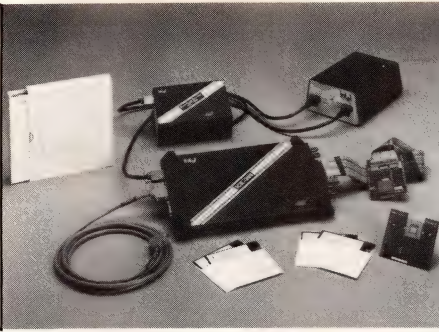
These improvements let you decode all interrupts and exceptions. You can also sort out and partition the various 8-, 16-, and 32-bit-wide bus transactions and correlate real-time events with code execution.

Applied Microsystems also added memory. You can now order the emulator with as much as 2M bytes of emulation memory (the first model had 512k bytes). However, downloading programs into 2M bytes of emulation memory via RS-232C or a GPIB link can prove to be a bottleneck. The company now offers a \$5990 SCSI option for downloading data to your emulator at rates to 1.5M bytes/sec.

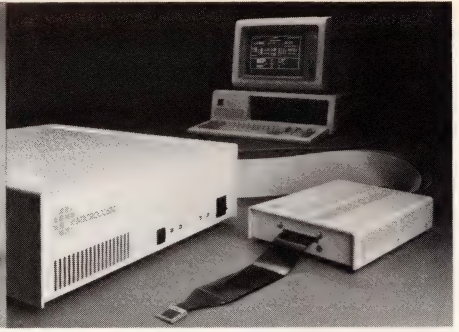
The SCSI link has a fully implemented disconnect/reconnect feature for efficient SCSI bus use even when transfer rates are limited by either your host or emulation processing speeds. In addition to the emulator-



8086 stand-alone in-circuit emulator controlled from a PC (Kontron Electronics)



80386 in-circuit emulator (Intel)



Low-cost 80286 in-circuit emulator (Microcosm)

specific commands, several of the standard SCSI commands are also supported, including Test Unit Ready, Request Sense, and Inquiry. Most of the single-byte SCSI messages are also available.

Applied Microsystems has also designed a low-profile, low-noise probe tip for the emulator. "We've had 68020 emulators working at 16.7 MHz for more than a year now," says Brian Grega, product manager for Applied Microsystems. "Our policy, however, is to not announce a certain speed capability on our emulators until they meet the minimum ac timing specs." Prices for the updated emulator begin at \$11,495.

Motorola's 68020 in-circuit emulator now operates to

25 MHz with no wait states. You have many choices for operating it: The emulator runs with Motorola's HDS-300 hardware/software development system, which, in turn, runs on an IBM PC, PC/XT, or PC/AT with a Motorola plug-in coprocessor module. The emulator is also compatible with Motorola's VME/10 development system and its VME system 1131. Moreover, you can use the HDS-300 in a stand-alone operation mode with a dumb terminal.

You can order the emulator with 64k bytes, 256k bytes, or 1M bytes of memory for \$8900, \$11,500, or \$14,400, respectively. (Emulation memory for the 68000 and 68010 processors is limited to 256k bytes. A 20-MHz version for the 68020 is also available.) The HDS-300 development system costs \$7125.

Controlled-impedance lines speed operation

Motorola's in-circuit emulator operates at 25 MHz when you run your programs in the target system's memory. From emulation memory, the maximum speed is 20 MHz with no wait states (one wait state max at 25 MHz). For the emulator to operate at 25 MHz or even 20 MHz, however, Motorola had to design the connection between the emulation pod and the target system's processor socket with controlled-impedance transmission lines. That little cable that runs out of the emulator pod and down to the chip costs Motorola approximately \$500. Some other manufacturers claim to achieve high emulation speeds with ribbon cable connecting the emulation pod to the target system.

Jim Huffman, engineering manager for Motorola's Development Systems Division, questions how these emulators run at such speeds with ribbon cable. He thinks the answer is that they can run at high speeds only in an ideal environment. However, if you try to push the microprocessor to its limits or try to do some exotic hardware circuitry, you may find that the emulator cannot run at full speed. Huffman believes that if you plan to push the speed of the 68020, you will need to buy a top-of-the-line emulator.

Atron's first 68000 Series emulator is for the 68020.

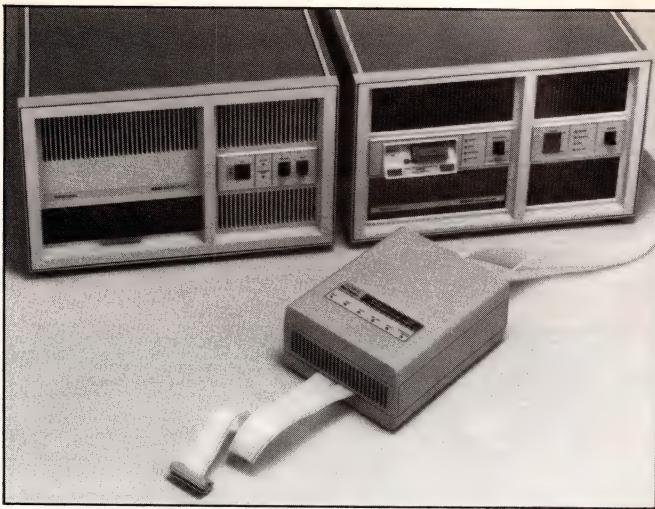


Low-cost 8088 in-circuit emulator (Nicolet)



16-MHz 80386 in-circuit emulator (Microtek International/Northwest Instrument Systems)

All of the third-party in-circuit emulator suppliers are now offering their products with communication links to PCs.



Development system and in-circuit emulator for the V20/V30 microprocessor (Tektronix)

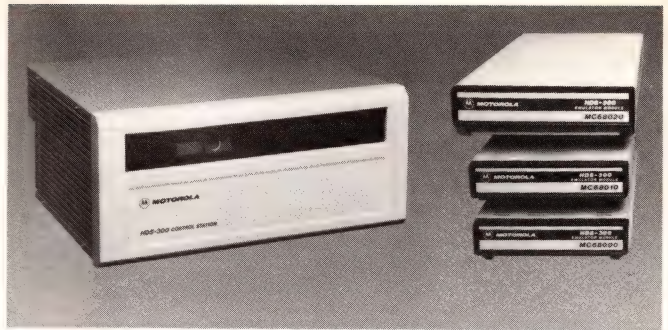
You can order either a \$13,450 16-MHz model or a \$13,925 20-MHz model, and the company has scheduled a \$17,995 25-MHz model for release this year as well. Atron's emulator consists of two boards, which fit in an IBM PC/AT, and the emulation pod. You can order as much as 1M bytes of emulation memory, which you can map into your target system in 128k-byte increments on any 64k-byte boundary. The link that allows you to download code from the PC/AT to your target system operates at speeds to 375k baud. You can ask the emulator to break on executing, reading, writing, fetching, and logic lines. The emulator's real-time trace can hold 2048 cycles of 32-bit address-bus and 32-bit data-bus information.

The Atron emulator is compatible with a number of programming languages available for the IBM PC and the PC/AT. You can use any of the languages that employ the Motorola S record format or the Tektronix format with Atron's symbolic debugger. You can also use Microtek's C and assembler language with the COFF superset object-module format.

The \$13,000 Microtek Mice-32/68020 in-circuit emulator's trace memory also holds 2048 cycles of information, including 32 bits of address, 32 bits of data, eight bits of status, eight bits of external trace data, and a 24-bit time stamp. You can order as much as 256k bytes of emulation memory and allocate the memory in 64k-byte increments, which can be located anywhere within the 68020's address space. You also can define each 16k-byte block within each 64k-byte increment to be enabled, disabled, or write protected.

The Mice-32/68020 in-circuit emulator can run as fast as 16.67 MHz if you are not using any overlay memory during emulation. If you are using the overlay memory, then the emulator can operate to 14 MHz without inserting any wait states and run above 14 MHz with one wait state inserted.

Tektronix's 68020 emulator is but one part of the Multi-V system that's used for software simulation, in-circuit emulation, and debugging. The basic system (no memory) costs \$6900; the emulator itself costs



68000-family development system (Motorola Inc)

\$10,500. The system connects to a VAX with either a 19.2-kHz RS-232C link or an Ethernet link. You can configure the Multi-V with two 68020 in-circuit emulators, each running as fast as 16.67 MHz when using only the target system's memory. You can also cascade four Multi-V systems for a total of eight emulators. The emulator provides full run-time support for designs containing multiple 68881 coprocessors.

The emulator also provides full cache support. You can debug code with the cache on or off. (A state logic analyzer is optional.) If you are employing a single emulator, then you can use as much as 12M bytes of emulation memory. If you are running two emulators, each emulator can have 3M bytes. You can map the emulator's standard 48k bytes of memory in 8k-byte increments and map the emulator's optional memory in 500k-byte increments.

Other μ Ps are not yet well supported

Although many microprocessors besides the Intel and Motorola ones have long been available, you will find little in-circuit-emulation support for them (Table 1). American Automation, Applied Microsystems, Hewlett-Packard, Kontron, Orion, and Tektronix support Zilog's Z8001 and Z8002 microprocessors. But only Applied and Orion support the Z8003, and Orion alone supports the Z8004.

Both Zax and Sophia Computer Systems support NEC's V Series processors. Sophia supports the V20/V30, whereas Zax supports the V20/V30 and the V40/



V40/V50 in-circuit emulator (Zax)

V50. The Zax ICD-378 V40/V50 in-circuit emulator (\$9995) provides transparent emulation to 8 MHz. It has 128k bytes of emulation memory, which you can map in 1k-byte increments. You can add more memory for a total of 1M bytes.

You can control the emulator with a terminal or a host computer, which can be an IBM PC, a VAX, or an Apollo or a Sun workstation. If you use a host computer with Zax's Zice-II communications utility software, you

can employ Zax's symbolic debugging, display logging, command journaling, help facilities, file upload and download, and batch command file execution features. Zax also offers compatible software development tools for the V40/V50, including C and Pascal compilers, crossassemblers/loaders, and object module librarians.

Fairchild's F9450 is supported by both Hewlett-Packard and Tektronix. The Hewlett-Packard emulator (\$4500 to \$8800) executes target system-based code to

TABLE 1—IN-CIRCUIT EMULATORS FOR 16- AND 32-BIT MICROPROCESSORS

		AMERICAN AUTOMATION	APPLIED MICROSYSTEMS	ATRON	EMULOGIC	HEWLETT- PACKARD	HUNTSVILLE MICROSYSTEMS	INTEL	KONTRON ELECTRONICS	MICROCOSM	MICROTEK	MOTOROLA	NATIONAL SEMICONDUCTOR	NICOLET INSTRUMENTS	ORION INSTRUMENTS	SOPHIA COMPUTER SYSTEMS	TEKTRONIX	ZAX
16-BIT MICROPROCESSORS																		
FAIRCHILD	9445																	
	9450					X											X	
FUJITSU	MBL8086																	
GTE COMMUNICATIONS	G655C816																	
HARRIS	80C86																	
HITACHI	HD68HC00																	
INTEL	8086	X	X		X	X	X	X	X	X	X			X	X	X	X	X
	8088	X	X		X	X	X	X	X	X					X	X	X	X
	80186	X	X		X	X		X	X	X					X	X	X	X
	80188	X	X			X		X	X	X					X	X	X	X
	80286	X	X			X		X		X					X		X	X
MIKROS SYSTEMS	MKS 1750A																X	
MOTOROLA	68000	X	X		X	X	X		X	X		X		X	X		X	X
	68010	X	X		X	X	X		X	X		X		X			X	X
NATIONAL SEMICONDUCTOR	32008																	
	32011																	
NEC	V20	X																
ELECTRONICS	V30	X														X		X
	V40															X		X
	V50															X		X
SIGNETICS	68070																	
WESTERN DESIGN CENTER	W65C8XX																	
ZILOG	Z8001	X	X			X			X						X		X	
	Z8002	X	X			X			X						X		X	
	Z8003		X												X			
	Z8004														X			
32-BIT MICROPROCESSORS																		
AT&T	WE32100																	
FAIRCHILD	CLIPPER																	
HITACHI																		
INTEL	80386							X			X							
MOTOROLA	68020		X	X	X						X	X					X	
NATIONAL SEMICONDUCTOR	32032																	
NEC	V60																	
ELECTRONICS	V70																	
ZILOG	Z80,000																	

Although 16-bit microprocessors have been available for years, the corresponding in-circuit emulators have been slow to appear.

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Using the emulator's memory during emulation generally produces wait states.

at least 15 MHz. If you use emulation memory, the emulator inserts three wait states. You can outfit the emulator with as much as 448k words of memory.

Tektronix supports the F9450 with its generic MIL-STD-1750A emulator (\$8700; probe, \$9800). You can order the emulator with as much as 128k words of emulation memory and use it with any implementation of the 1750A specification, including single-chip, multi-chip, bit-slice, or board-level processors.

The future is embedded

If Jim Huffman of Motorola is right, in-circuit emulators are going to change dramatically. He believes that the 68030 will be Motorola's last microprocessor to use a traditional in-circuit emulator for hardware debug. For future chips, "We will be doing what we call embedded emulation. Embedded emulation means just that. We put the emulation right on the silicon." Emulation on silicon means that a processor's speed is no longer an issue. "You will always be able to control the processor," Huffman posits. "The advantage that you have over a standard debugger is that the [target system] doesn't have to work—just the processor. Just shoot

the juice to the processor, run some clock to it, and as long as it runs, it will allow you to test everything else."

Huffman sees some other probable advantages in embedding the emulation in silicon. You could, for example, access all the internal registers. In the future, you may be able to break emulation on the contents of an internal register, or break on addresses or data on the internal buses. Ultimately, you will be able to monitor the contents of the registers themselves, not just the contents of the data lines passing through. The cost of building an emulator for one of these new chips is \$3.59, Huffman estimates. "The directions for emulation will be in the data sheet. So you will flip open the last page of the data sheet and it will show you a little level converter to convert RS-232C to the chip level. I think it takes three buffers. That's it. You've spent your wad on an emulator."

EDN

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

For more information . . .

For more information on the 16- and 32-bit in-circuit emulators described in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

American Automation
2651 Dow Ave
Tustin, CA 92680
(714) 731-1661
TWX 910-595-2670
Circle No 588

Applied Microsystems Corp
5020 148th Ave
Box C-1002
Redmond, WA 98052
(206) 882-2000
TLX 185196
Circle No 589

Atron
20665 Fourth St
Saratoga, CA 95070
(408) 741-5900
Circle No 590

Emulogic Inc
3 Technology Way
Norwood, MA 02062
(617) 769-2980
TWX 710-336-5908
Circle No 591

Hewlett-Packard Co
1820 Embarcadero Rd
Palo Alto, CA 94303
Phone local office
Circle No 592

Huntsville Microsystems
Box 12415
Huntsville, AL 35802
(205) 881-6005
TWX 510-600-8258
Circle No 593

Intel Corp
Literature Dept
3065 Bowers Ave
Santa Clara, CA 95051
(408) 987-8080
Circle No 594

Kontron Electronics Inc
630 Clyde Ave
Mountain View, CA 94039
(415) 965-7020
TWX 910-367-5207
Circle No 595

Microcosm Inc
15275-E SW Koll Parkway
Beaverton, OR 97006
(503) 626-6100
TLX 759527
Circle No 596

Motorola Inc
Microsystems Div
Box 2953
Phoenix, AZ 85062
(512) 440-2839
Circle No 597

National Semiconductor
2900 Semiconductor Dr
Santa Clara, CA 95051
(408) 721-5644
Circle No 598

Nicolet Instruments Corp
Test Instruments Div
5225 Verona Rd
Madison, WI 53711
(608) 271-3333
TWX 910-286-2737
Circle No 599

Microtek International
Northwest Instrument Systems (US sales)
19545 NW Von Neumann Dr
Beaverton, OR 97006
(503) 690-1300
Circle No 600

Orion Instruments
702 Marshall St
Redwood City, CA 94063
(415) 361-8883
TLX 530942
Circle No 601

Sophia Computer Systems
3337 Kifer Rd
Santa Clara, CA 95052
(408) 733-1571
Circle No 602

Tektronix Inc
Box 1700
Beaverton, OR 97077
(800) 547-1512
in OR, (800) 452-1877
Circle No 603

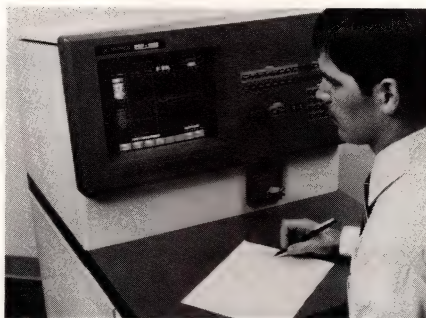
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Instruments

Digital oscilloscope is world's first superconducting electronic product

At a time when other instrument makers are struggling to push existing electronics technology past limits such as 1G samples/sec, this manufacturer's PSP-1000 50-GHz sampling digital oscilloscope actually is what many other products only claim to be: a revolutionary instrument. The PSP-1000 not only sports unprecedented bandwidth for a digitizing instrument, but it is also the first commercial product to incorporate superconducting electronics.

The instrument uses a super-cooled chip operating at four degrees above absolute zero (-459°F), and its front-end specs surpass



those of any other digitizing instrument on the market by a considerable margin. It sports a 5-psec rise time, a bandwidth of 70 GHz, and a maximum sensitivity of $50\ \mu\text{V}$.

The single- or dual-channel unit also accepts plug-ins that allow you to configure it as a TDR (time-do-

main reflectometer). The instrument has voltage ranges of 10 mV, 100 mV, and 1V. Its dynamic range is 46 dB, and it can store as many as 1024 data points. Its effective sampling sweep speeds range from 5 psec/div to 1 nsec/div. The unit has built-in math functions for common waveform calculations, including FFTs. Its CRT can show four waveforms, markers, and trace annotations. PSP-1000 mainframe, \$120,000; plug-ins, from \$20,000 to \$45,000.

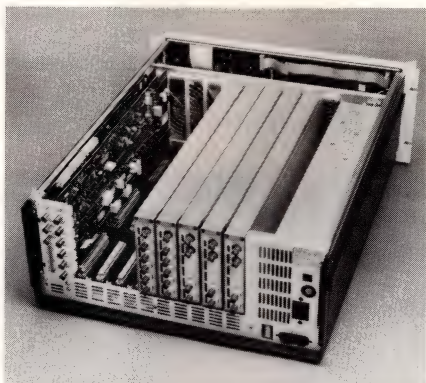
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The Model 680 instrument system incorporates a proprietary 32-bit bus based on the VME Bus and called the HMIB (high-speed modular instrument bus). The HMIB has a maximum transmission rate of 100 MHz for 16- or 32-bit data. The 680 comprises a chassis and front panel, slots for eight IACs (instruments on a card), an I/O processor board, a reference and calibration (Ref/Cal) board, and a temperature-controlled fan.

The IACs plug into three 96-pin DIN connectors. In addition to standard VME Bus signals, the connectors provide a system-sync bus and a system trigger bus, both of which are accurate to 1 nsec. The connectors also carry a 10-MHz and a 100-MHz system clock, both accu-



rate to ± 1 ppm, along with other intermodule-linking signals.

One connector supports a high-speed analog bus. This bus sums outputs to create complex waveforms from signal-generating IACs.

You can control the instrument from its front panel or over the IEEE-488 bus. An optional inter-

face board handles the Air Force's MATE (Modular Automatic Test Equipment) hardware interface and CIIL (Control Intermediate Interface Language) software interface.

The manufacturer currently has three IACs for the HMIB: the 680-001 20-MHz arbitrary-waveform generator (\$3000), the 680-002 pulse/timing generator (\$3200), and the 680-004 high-speed pulse/timing generator (\$3950). In addition, Datron (Stuart, FL) offers the 680-005, a $5\frac{1}{2}$ -digit DVM (\$2950), and Racal Dana (Irvine, CA) has announced the 680-006 counter/timer (\$2800). The 680 mainframe costs \$6700.

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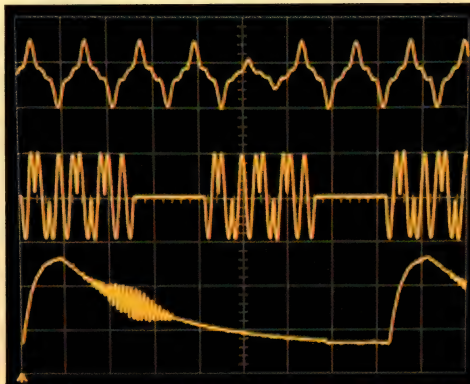
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A signal source should simulate a "real world" waveform. In the past, only sine waves, square waves, ramps or pulses were available for high speed applications. But using these limited waveforms, how could circuits be tested under actual conditions? Such as testing a threshold detector by varying the amplitude of a single pulse out of a hundred? Or a phase detector by varying the phase of one cycle out of a thousand? Or test an equipment setup with a replica of an actual waveform? All too often, this kind of testing wasn't done at all or was extremely hard to do. But now the LeCroy 9100 solves all these problems and many, many more.



"Real World" Waveforms: Disk Head (top), PSK ASC II "k" (middle)
Flourescence Decay (bottom)

It's Easy

Creating new waveforms is easy with LeCroy's Optional EASYWAVE™ software package designed for use with the IBM PC™ and most compatibles. Simply select some basic shapes from a library, add them together, and then stretch them to the amplitude and time duration that you desire. Or acquire "real world" waveforms with LeCroy digitizers and digital oscilloscopes.

It's Affordable

The LeCroy Model 9100 frees you from the limitations of standard function generators and, at less than \$9,000*, it won't wreck your budget. For that price you get waveform linking, channel summing, 8-bits resolution, 12-bits dynamic range, 64 kpoints fast memory, 350 kpoints of non-volatile waveform storage, six standard waveforms. Start improving your design and product quality with high-speed, custom waveforms using the LeCroy 9100 AFG. For more information circle the reader service number or call us at: 914-425-2000 for a demonstration.

*USA price only

Circle 57 for information

LeCroy

700 South Main Street, Spring Valley, NY 10977, USA. Tel: (914) 425-2000
Route du Nant-d'Avril 101, 1217 Meyrin 1-Geneva, Switzerland. Tel: (022) 82 33 55

ASIC verifier correlates physical device to design parameters

Using scanning-electron-microscope technology, the IDS 5000 allows you to observe the response of ASICs to test signals. The instrument has a built-in vacuum chamber (scanning electron microscopes work in a vacuum) for the device under test. A fixture in the vacuum chamber holds the device; the chamber also brings out electrical connections so that you can stimulate the device under test electronically and monitor its response.

The instrument's scanning electron microscope can detect the presence or absence of electrical activity in small areas of the device under test. It can scan the device under test quickly enough to correlate the observed electrical activity in the

chip to the chip's response to test vectors. This scheme enables you to perform programmable, nonintrusive probing of a physical device, and it replaces mechanical probe stations.

To correlate the physical and test-vector phenomena, the tester must know the chip's physical layout. The instrument's controller uses net lists and other information from CAD/CAE software to determine the chip's layout.

The controller's software drives windows that display several aspects of the device under test. One window shows a microimage of the portion of the device under test currently being investigated, while a second window shows a circuit dia-

gram corresponding to that same area of the IC. The system operator can direct the system to move its point of view to any area of the physical device or the circuit diagram.

Another window displays the results of its nonintrusive, electron-beam probing in real time. Still others display test-vector and ASIC-response waveforms. IDS 5000, \$495,000. Delivery, 90 days ARO.

Sentry/Schlumberger VHSIC Test Systems, Advanced Products Group, 1601 Technology Dr, San Jose, CA 95110. Phone (408) 437-5000. TWX 910-338-0558.

Circle No 574

Waveform digitizers capture 350-MHz, single-shot signals

The 3000 Series waveform digitizers offer a 1-nsec, real-time sample interval (1G samples/sec). When measuring repetitive signals, the instruments can achieve 10-bit resolution. Their single-shot resolution is 8.0 effective bits for a maximum-bandwidth, 350-MHz waveform. Their time-base accuracy specs $\pm 0.01\%$, and their aperture jitter is < 3 psec rms. The input-voltage range is 200 mV to 5V rms (dc coupled).

The Model 3000 requires an IBM PC for control. The firm supplies IBM PC software that can control as many as eight digitizers at once. The software displays captured data



in the time and frequency domains. It offers a choice of Hamming, Hanning, and user-defined windowing functions. The PC can display a new FFT at least once per second when the digitizer is in the continu-

ous-acquisition mode.

The Model 3100 is the IEEE-488 version of the same instrument. The 3100 has a programmable input attenuator. Like the IBM PC version, it has external arm and trigger inputs and features autocalibration. You can pretrigger by as many as 992 samples and posttrigger by as many as 127k samples. Both instruments have 1024-sample memories. Model 3000, \$28,500; Model 3100, \$31,500. Delivery, 60 days ARO.

Sequence Inc, 1650 Zanker Rd, San Jose, CA 95112. Phone (408) 436-6065.

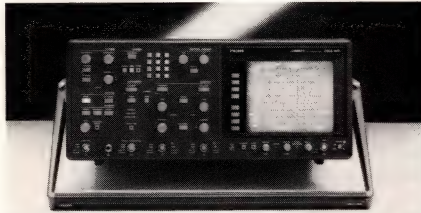
Circle No 581

Instruments

Digital storage oscilloscope captures 250M samples/sec, has 10-bit resolution

The PM3320 digital storage oscilloscope (DSO) provides an equivalent analog bandwidth of 200 MHz for repetitive waveforms; in single-shot mode, it captures a minimum-length record of 512 input samples at 4-nsec intervals. The instrument digitizes input signals to an accuracy of 10.0 equivalent bits. For single-channel operation, its memory depth is 4096 samples max; for dual-channel operation, it is 2048 max samples/channel.

The instrument's separate glitch-capture section records the presence of glitches as short as 3 nsec. Math functions include rise-time and peak-to-peak value determination, rms- or mean-value calculations, and the removal of dc offsets



as high as 300V.

The 10×12-cm CRT display shows both captured waveforms and instrument settings. The scope can transfer the entire screen to a digital plotter without the aid of a controller.

The scope locates traces rapidly by automatically selecting appropriate timebase and vertical-deflection sensitivities.

Two on-screen cursors allow you to take measurements on captured

traces. Moreover, you can use these cursors to define a portion of the captured waveform that you wish to view in more detail.

An optional interface provides IEEE-488 and RS-232C interfaces and a real-time clock. The PM3320 costs \$9900; delivery, eight weeks ARO.

Philips Industrial and Electro-acoustic Systems Div, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

Circle No 577

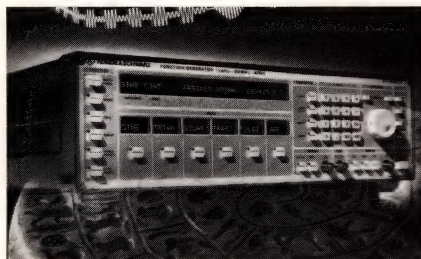
Philips Test & Measuring Instruments Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800. TWX 710-988-5348.

Circle No 578

Function generator produces user-defined waveforms

Covering the frequency range from 1 μ Hz to 20 MHz, the AFGU function generator produces sine, triangular, square, trapezoidal, and pulse waveforms. In addition, it lets you define your own output waveforms with 10-bit amplitude resolution.

The user-defined waveforms are stored in 4k words of internal memory. You can select the start and stop addresses in this memory to generate segments of stored waveforms, or to hold several different waveforms at one time. You can enter waveforms either via the keyboard, or via the instrument's IEEE-488 interface. Automatic interpolation between points reduces the number of points required for



keyboard entry of waveforms. You can also select the sampling period of the memory between 100 nsec and 327.6 sec, so you can generate output frequencies as high as 3.33 MHz.

The generator's output amplitude is variable from 0 to 30V p-p, and its output impedance is switchable (50 Ω or <5 Ω). In addition, you can introduce an output offset as great as ± 15 V. The unit's operating

modes include continuous, gated, burst, half-cycle burst, harmonic-frequency, and subharmonic-frequency outputs, and you can perform linear or logarithmic frequency sweeps.

Its modulation modes include internal or external FSK and pulse modulation, and external AM, FM, and VCO modulation. DM 18,500.

Rohde & Schwarz GmbH & Co KG, Muhldorfstrasse 15, 8000 Munich 80, West Germany. Phone (089) 41290. TLX 523703.

Circle No 579

Rohde & Schwarz-Polarad Inc, 5 Delaware Dr, Lake Success, NY 11042. Phone (516) 328-1100. TWX 510-223-0414.

Circle No 580

EDN July 23, 1987

KEITHLEY ON SWITCHING:

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Our line of 18 signal switching cards is the widest variety anywhere, so you can configure a system to match your signal types without sacrificing system performance.

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Matrix	Most flexible
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Sensitivity	Currents to 40fA, voltages to 30nV
High Level	Currents to 5A, voltages to 1000V
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Keithley switches let you customize applications by mixing cards in two or 10-slot mainframes. For larger systems, you can connect up to five mainframes and program them at one IEEE-488 address.

Keithley switching further simplifies system integration with digital I/O, triggers in/out, relay setup memory, inspect mode for determining relay configuration, and more.

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Keithley Instruments Inc., 28775 Aurora Road, Cleveland, Ohio, 44139 (216) 248-0400.

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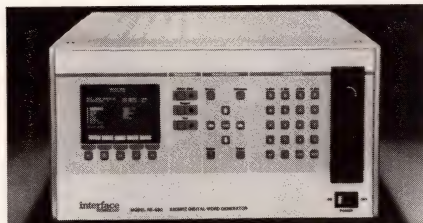
KEITHLEY

Instruments

Digital word generator operates at 250-MHz data rates across 32 channels

The Model RS-690 digital word generator drives device inputs at rates as high as 250 MHz across 32 channels. It has 50-psec edge-placement resolution and 10-mV amplitude resolution. No other currently available pattern generator can run as many channels at 250 MHz as the RS-690 can.

The word generator operates at a basic clock speed of 62.5 MHz and accepts one or two 64-channel cards. Each channel has 1k bits of memory. The generator achieves higher clock rates, at the expense of channel width, by interleaving channel memories and time-multiplexing their outputs. If you need more



memory, you can continue to interleave memories without increasing the data rate.

The ECL outputs at the back of the RS-690 feed 16-channel fixed ECL-level output pods, 16-channel fixed TTL-level output pods, or 4-channel variable-amplitude pods.

You can program the variable-amplitude pod outputs to provide a pulse of as much as 5V p-p in a $\pm 5V$

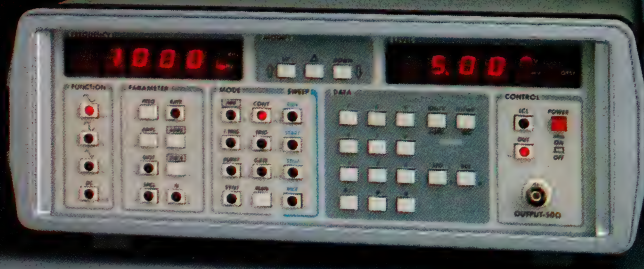
range. No other generator provides variable voltage outputs at 250 MHz.

You can control the instrument from its front panel or via IEEE-488 or RS-232C interfaces. The RS-690 also has a 5¼-in., IBM PC-formatted floppy-disk drive for storing test setups and data patterns. With one 64-channel card, the RS-690 costs \$27,000; output pods cost from \$1500 to \$5000 each. Delivery, eight weeks ARO.

Interface Technology, 2100 E Alosta Ave, Glendora, CA 91740. Phone (818) 914-2741. TLX 4945489.

Circle No 575

BE ARBITRARY.



Nicolet Programmable Function Generators

- Fully GPIB (IEEE-488) programmable
- Arbitrary waveform generation (12-bits x 2k)
- Standard functions to 4 MHz
- Comprehensive sweep capabilities including arbitrary sweep!
- Simultaneous display of amplitude and frequency
- Nonvolatile storage of 99 setups
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Microprocessor Development Systems & In-Circuit Emulators



SA2000

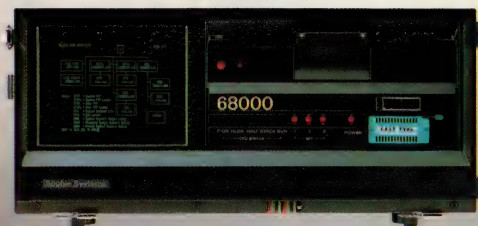
Complete universal development system and in-circuit emulator for latest micro controllers.

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SA700-68000

Dedicated in-circuit emulator for 68000 Microprocessor.

- Most transparent 68000 emulation.
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SA710M

16-bit universal system analyzer and in-circuit emulator.

- Symbolic features include local variables, arrays, structures.
- Start/Stop trace without breaking.
- Stand-alone or Host operation.

PROCESSOR (16bit)		PKG	SA710M	SA700-68000
INTEL	8086/88	DIP40P	○	
	80C86/88	DIP40P	○	
	80186/188	LCC/PGA	○	
NEC	μPD70108/116 (V20/30)	DIP40P	○	
	μPD70208/216 (V40/50)	PGA	○	
MOTOROLA	MC68000	DIP64P,PGA68P		○
PROCESSOR (8bit)		PKG	SA2000	
ZILOG	Z80CMOS (Z80, Z80A, Z80C)	DIP40P	○	
	Z80H (Z80, Z80A, Z80B, Z80H)	DIP40P	○	
	Z8 (Z8601/03/11/13-12R)	DIP40P	○	
INTEL	SUPER-8 (Z8310-33)	DIP40/48P	○	
	80C85, 8085AH-2	DIP40P	○	
	8048 (8035/39/40/49/50AH)	DIP40P	○	
MOTOROLA	8051 (8031/51AH, 80C51)	DIP40P	○	
	MC6801 (6801/03-1)	DIP40P	○	
	MC6809 (68A09, 68809)	DIP40P	○	
HITACHI	MC6809E (68A09E, 68B09E)	DIP40P	○	
	MC68HC11	DIP48P	○	
	HD6301V/6303R, HD63701V	DIP40P	○	
NEC	HD6301X/6303X, HD63701X	SDIP64P	○	
	HD6301Y/6303Y, HD63701Y	SDIP64P	○	
	HD6305U/V, HD63705V	DIP40P	○	
MITSUBISHI	HD6305X/Y	SDIP64P	○	
	HD6305Z, HD63705Z	FLAT80P	○	
	HD6309E	DIP40P	○	
ROCKWELL	HD61810B (HSP)	DIP40P	○	
	μPD 7807/08/09	SDIP64P,QUIP64P	○	
	μPD7810H/11/14/16	SDIP64P,QUIP64P	○	
MITSUBISHI	μPD78C10/11	SDIP64P,QUIP64P	○	
	M50734SP	SDIP64P	○	
	M50745	SDIP64P	○	
ROCKWELL	M50747	SDIP64P	○	
	R6502, 65C02	DIP40P	○	

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Corporate Headquarters: Japan, Sophia Systems Co., Ltd. NS Bldg. 2-4-1, Nishishinjuku, Shinjuku-ku, Tokyo 163. Tel.(03)348-7000.

Introducing Gould's K450B Logic Analyzer.



**80 channels at 100 MHz
for power to spare. Fast.**

Quick-shift from timing jobs to state, from easy jobs to complex ones, with ease.

At last, a logic analyzer with the power for any situation.

Only the K450B gives you up to 80 channels w/10 ns resolution, or 40 w/5 ns resolution. Even on 32-bit devices, you can analyze state *and* detailed timing without probe switching. Think of the extra time you will have and the headaches you won't.

Another breakthrough is what makes all that power easy to use anytime, on any job. It's Auto Setup™, the first automatic configuration system.

All you do is push a button. Probes are checked for activity. Threshold and appropriate clock speed are set.

Channels are arranged on the screen. You get usable data in 60 seconds or less. On all channels!

80 ch. @ 100 MHz / 40 ch. @ 200 MHz

And don't overlook the K450B's other standard features: Ample 2K/4K memory. Auto Save for unattended triggering on preprogrammed events. Built-in disk drive. An advanced remote diagnostics function. A "Help" key when you need it. And many more. You can also order disassemblers for most popular microprocessors.

Try the K450B once, and you'll agree—not since the famous Gould Biomation K100 has a new product so elevated the performance standards for logic analyzers.

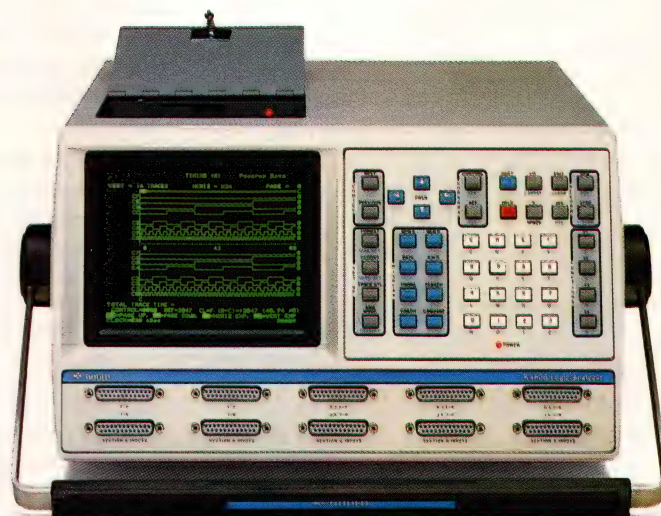
For a K450B data sheet, an application note on Trace Control™ (our unique triggering system), and the Gould Test & Measurement Systems catalog, write: Gould Inc., Test & Measurement Group, 19050 Pruneridge Ave., Cupertino, CA 95014. Or call these toll-free numbers:

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4Kx9 FIFO 50ns ACCESS TIME

Organization	Access Time	Features
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2Kx9 IDT 7203	50ns	" "
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Replaces
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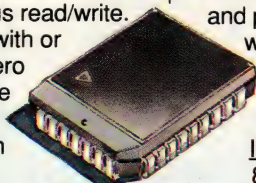
Reduces pin count
& board space

Lower cost per bit

Introducing the world's first 4Kx9 CMOS FIFO.

Reduce your part count and lower the price per bit. The IDT7204 50ns (access time) 4Kx9 and IDT7203 50ns 2Kx9 are the world's largest fast FIFOs. Both are fast enough to interface with the fastest microprocessors available. Both are pin and functionally compatible with the IDT7202 35ns 1Kx9, and the IDT7201 35ns 512x9 FIFOs. A single IDT7204 can replace eight IDT7201s.

Dual-ported architecture. Asynchronous and simultaneous read/write. Can buffer any data rate, with or without system clock. □ Zero fall thru time—able to write a word into the FIFO and read the same word out on the next cycle.



Flags. Three flags—full, J-Leaded PLCC, empty and half-full—indicate the extent of FIFO memory usage.

Data integrity. The x9 FIFO organization allows a parity or tag bit to be appended to a data word.

Easily expandable. Built-in hooks to make deeper and wider FIFOs without external logic. Deeper FIFOs are especially useful when performing data acquisition functions or when storing frame information in a graphics system.

Retransmit capability in single device mode. The retransmit pin resets the read pointer to the initial FIFO data position and restarts data transmission.

CMOS power. Maximum current is 120mA (commercial).

Packaging. Standard 28-pin ceramic and plastic DIPs and 32-pin LCC and PLCC.

High-density FIFO modules.

When we introduced our 512x9 and 1024x9 monolithics in 1984, we also introduced 2Kx9 and 4Kx9 modules and promised monolithic replacements would be available in the future.

We have kept that promise with the IDT7203/4. Now we have two new modules—IDT7M206 16Kx9 and IDT7M205 8Kx9—providing extraordinary density and again paving the way for deeper monolithic FIFOs.

Introducing the world's fastest and largest parallel/serial FIFOs.

The IDT72103 2Kx9 and IDT72104 4Kx9 FIFOs perform serial-to-parallel, parallel-to-serial, serial-to-serial and parallel-to-parallel data operations. Flexishift™ feature allows you to program serial word widths to be anything from 4 bits wide to as wide as you want.

Fastest CMOS multipliers & MACs.

16x16 Multipliers: IDT7216/7217 replaces MPY016H/K and Am29516/17. Com'l. speed (worst case) is 35ns.

16x16 Multiplier/Accumulators: IDT7210 (35-bit output) replaces TDC1010. □ IDT7243 (19-bit output) replaces TDC1043. Com'l. speed (worst case) is 35ns.

12x12 Multipliers: IDT7212 replaces MPY012. □ IDT7213 has a single clock. Com'l. speed (worst case) is 30ns.

12x12 Multiplier/Accumulator: IDT7209 replaces TDC1009. Com'l. speed (worst case) is 30ns.

64-bit IEEE Floating Point Multiplier and ALU: IDT721264/65 replaces Weitek 1264/65. □ 50% faster □ 12.5 megaflops, 64-bit ALU □ 6.25 megaflops 64-bit multiply □ 350mW per part, typical.

May we be of assistance?

If you need to design commercial systems with uncompromising performance at the right price, call your local IDT representative or 1-800-IDT-CMOS.

When cost-effective performance counts



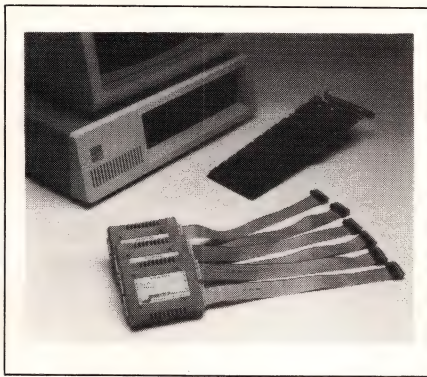
Integrated Device Technology

Digital Signal Processing Division

3236 Scott Blvd.
Santa Clara, CA 95054-3090
(408) 727-6116
TWX 910-338-2070

CIRCLE NO 84

Instruments



BIT-SLICE DEVELOPER

The low-cost, entry-level Microstep Development Station comprises an IBM PC/XT or PC/AT interface card, one or more pods that substitute for the microprogrammed memory of the target system under development, control software, and a meta-assembler. With this hardware/software package you can develop bit-slice or microprogrammed systems. The control software includes a set of debug and breakpoint commands for debugging your microprogram as it runs in your target system. The macro meta-assembler produces relocatable, linkable microcode. The basic package includes one 128-bit \times 4k-microword, 40-nsec pod. Other pods are available. \$3695 (hardware only); \$6195 (including meta-assembler).

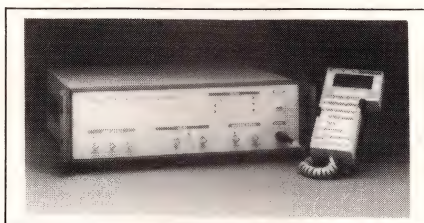
Step Engineering, 661 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 733-7837.

Circle No 351

ARBITRARY GENERATOR

The Model 9100 dual-channel, arbitrary-function generator can generate 8-bit samples at 200M samples/sec in single-channel mode (100M samples/sec in dual-channel mode). You can also sum the two channels internally for an effective 12-bit dynamic range. The generator has a 64k-sample memory. You can step through the sample memory sequentially or algorithmically. The instrument also has a 350k-sample RAM disk for internal, off-line storage of additional waveforms.

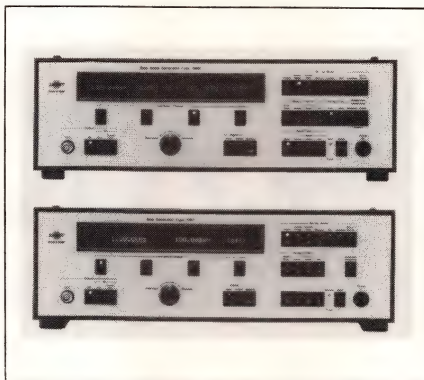
Its built-in waveforms comprise



sine, square, triangle, ramp, and pulse waves. Optional waveform-creating software is available. You can control the instrument via IEEE-488 and RS-232C interfaces, or manually, with an optional control panel. Model 9100, \$8900; control panel, \$700; software, \$1300. Delivery, 12 weeks ARO.

LeCroy Research Systems, 700 S Main St, Spring Valley, NY 10977. Phone (914) 578-6084. TWX 710-577-2832.

Circle No 352



GENERATORS

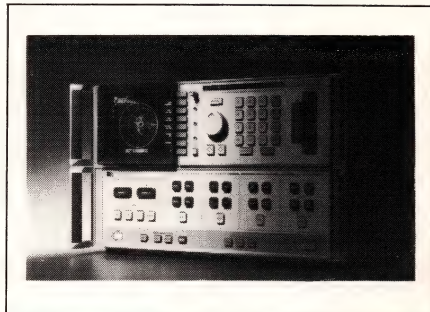
Models 1049 and 1051 are a pair of 6-decade, swept-frequency signal generators that cover the frequency range of 0.2 Hz to 200 kHz with 0.001-Hz resolution. Their harmonic and spurious distortion is < -96 dB from 20 Hz to 20 kHz (-85 dB outside this band). The amplitude linearity is ± 0.05 dB over the same band (± 0.2 dB outside), and the clock stability is $\leq \pm 5 \times 10^{-6}$ /year.

You can enter a 1024-point amplitude-weighting function from the front panel or via the IEEE-488 bus for automatic equalization of swept-output level vs frequency. Both models have internal linear and logarithmic sweep, plus an amplitude-learn mode. Model 1049 also features white, pink, and narrowband

noise and an in-circuit, 126-dB compressor. An IEEE-488 interface is standard. Model 1049, \$16,499; Model 1051, \$10,676.

Brüel & Kjaer Instruments Inc, 185 Forest St, Marlborough, MA 01752. Phone (617) 481-7000. TWX 710-347-1187.

Circle No 353



NETWORK ANALYZER

The Model HP 8510B microwave network analyzer measures both the magnitude and the phase of transmission and reflection coefficients over the frequency range of 45 MHz to 26.5 GHz. When you add accessories, the instrument's frequency range extends to 100 GHz. The instrument has a 100-dB dynamic range with 0.001-dB magnitude resolution, 0.01° phase resolution, and 10-psec group-delay resolution. Its time-domain option permits you to measure network response as a function of physical distance. The instrument's measurements are NBS traceable.

The analyzer can control two separate frequency sources directly without a controller. An internal computer calculates error-corrected results from measured data. The maker can retrofit a performance-upgrade kit to the earlier 8510A to bring it up to the B model's specs. Model 8510B, \$33,800; time-domain option, \$9000; upgrade kit, \$12,500 before November 1987, \$15,000 thereafter. Delivery, eight weeks ARO.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 354

We've lowered prices on the HP 54100A/D 1 GHz Digitizing Oscilloscopes. So you can get a great, general-purpose HP scope for substantially less.

The HP 54100A, originally \$17,600, is now just \$12,900.**

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Take advantage of our lower prices now. Contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

*HP 54100A only. **U.S.A. price only.

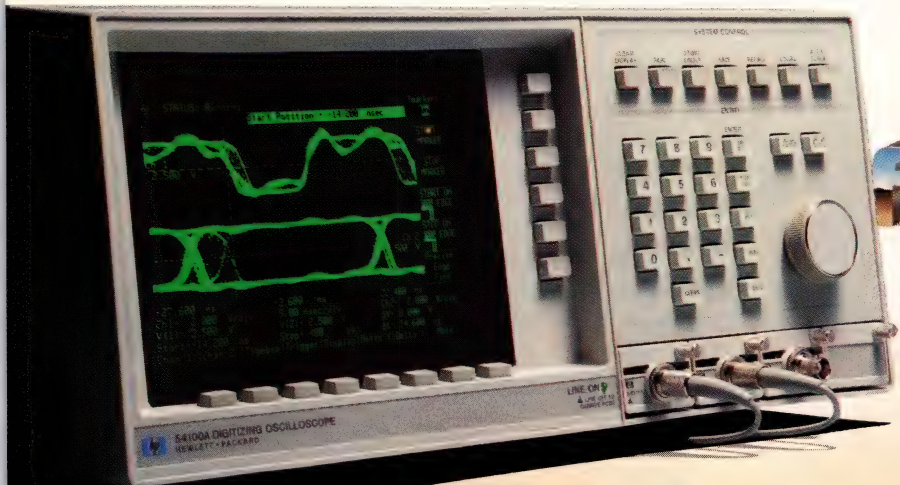


**HEWLETT
PACKARD**

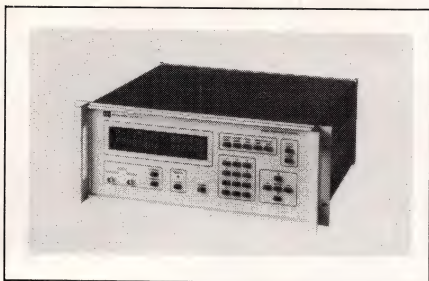
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Instruments



PHASE STANDARD

The Model 5000 phase-angle standard provides two digitally synthesized sine waves whose phase is controllable from -999.999 to $+999.999^\circ$. The instrument's phase-angle resolution is one millidegree over its frequency range of 1 Hz to 100 kHz. Each sine wave is individually adjustable from 100 mV to 11.9V. The phase accuracy from 1 Hz to 1 kHz is $\pm 0.003^\circ$ typ, decreasing to $\pm 0.05^\circ$ at higher frequencies. The unit is fully programmable over the IEEE-488 bus. The sine-wave outputs have -74 -dB max total distortion. \$9400.

Clarke-Hess Communication Research Corp, 220 W 19th St, New York, NY 10011. Phone (212) 255-2940.

Circle No 355



MIXED ATE

The HP 9480 mixed-signal IC ATE handles such devices as flash-converter, DAC, and DSP chips. The 128-pin tester supplies eight channels of dc stimulus from 100 μ V to 100V at 1 pA to 100 mA. The ac waveform generator supplies 128-MHz sine waves or 32-MHz arbitrary waveforms. The tester's waveform digitizer samples to 16 bits at 1 MHz and to 12 bits at 20

MHz. Its digital pattern generator and pattern analyzer both have 16k-sample memories and run at 128M samples/sec.

The tester's controller runs Unix System V with real-time extensions. You program it in a proprietary language that the company claims is somewhat like Pascal. Approximately \$650,000. Delivery, 14 weeks ARO.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 356

DIGITAL THERMOMETER

The DT-160 pocket-sized digital thermometer measures 0 to 159.8°F. It has a temperature sensor mounted on its front panel. The sensor allows you to select a display of room temperature or probe temperature. The unit also has a built-in clock and a built-in tilt stand. You can program the unit to sound an alarm if it senses temperature excursions beyond either of two preset limits. \$45.

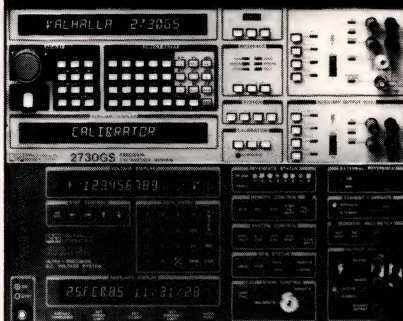
A W Sperry Instruments Inc, 245 Marcus Blvd, Hauppauge, NY 11788. Phone (516) 231-7050.

Circle No 357

68020 PACKAGE

A 68020-specific pod for the company's μ P-development system emulates the chip's bus architecture and prefetch characteristics at clock speeds to 16.67 MHz. A complete setup includes the pod, the company's DE-1000 emulator module, and a host computer (IBM PC, VAX, or MicroVAX). The emulator has eight hardware breakpoints. The pod inserts the 68020's breakpoint op code into the μ P's prefetched instruction stream in real time without modifying your program in memory. The pod will execute breakpoints regardless of the width of the data or instruction the μ P is fetching. A 68020 pod, a DE-1000 emulator, and

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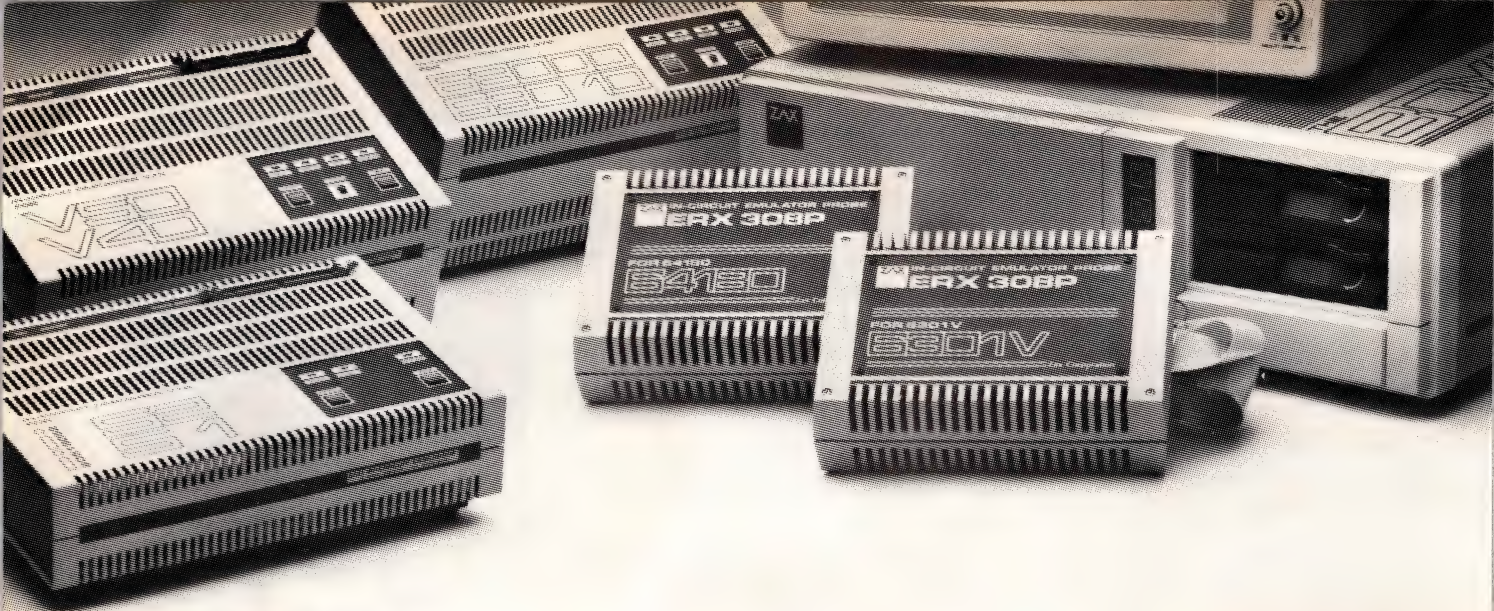
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CIRCLE NO 47



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All ZAX Emulators contain an internal processor, "loanable" RAM and extensive debugging mechanisms. They function in real-time and are rated at the same clock speed as the manufacturer's processor. The emulators introduce no added wait states so the prototype program can be executed exactly as the processor would and in the same length of time.

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ZAX

Zax Corporation

Instruments

MS-DOS software cost \$15,295.

Emulogic Inc, 1 Edgewater Dr, Brookside Park, Norwood, MA 02062. Phone (617) 769-2980. TLX 710-336-5908.

Circle No 358

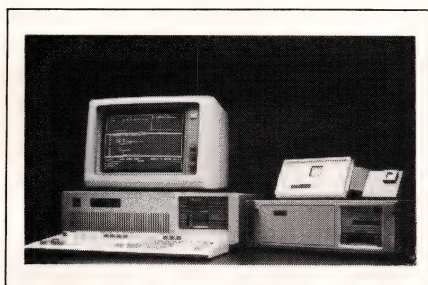


MIXED ATE

The A500 analog-digital ATE tests semiconductor devices, such as digital-signal processors or digital TV chips, that have both digital and analog functions. The tester can have 80 digital I/O pins and 16 analog I/O pins. You can choose from a variety of digital-vector memories and arbitrary-waveform generators. For example, a 256-kHz waveform generator features a 100-dB signal-to-noise ratio. The fastest digital source runs at 25 MHz (50 MHz multiplexed), and the fastest analog source runs at 10 MHz. The proprietary tester software runs under Berkeley Unix 4.2. \$850,000 to \$2,000,000.

Teradyne Inc, 321 Harrison Ave, Boston, MA 02118. Phone (617) 482-2700. TWX 710-321-1055.

Circle No 361



68000 DEBUGGER

The Validate-X-Ray debugging software package works with 68000-family μ P code. The debugger allows you to set breakpoints and single-step programs written in high-level code. The package works with the Microtec Research (Santa Clara, CA) C compilers and runs on the Applied Microsystems ES 1800 Series in-circuit emulators. It lets you monitor the stack's frames and debug assembly-level code. \$3500.

Applied Microsystems Corp, Box 97002, Redmond, WA 98073. Phone (800) 426-3925; in WA, (206) 882-2000. TLX 185196.

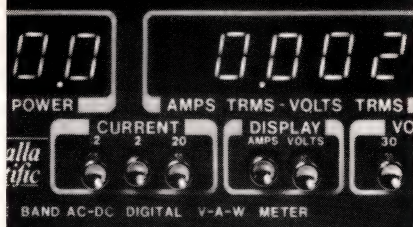
Circle No 360

COUNTER

The PM 6665 is a 2-channel counter/timer with an input range of 0.1 Hz to 120 MHz and a timing resolution of 100 nsec in single-shot mode and 20 psec in averaging mode. The frequency resolution amounts to a minimum of seven digits for a 1-sec measurement time. You can add a third input channel with 1.1-GHz frequency capability, and you can add a mathematically compensated crystal timebase, which improves the instrument's basic temperature drift over 0 to 50°C from 10 to 0.2 ppm.

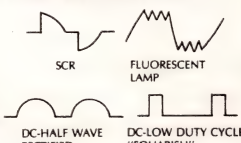
The two main input channels have variable sensitivity controls for frequency measurements, and variable trigger-level control over ± 5 or ± 50 V input ranges for time measurements. Additional functions in-

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CIRCLE NO 86

Instruments

clude channel A/B ratio measurements, time interval A-B, totalize, and rpm display. An IEEE-488 interface, a battery pack, and a rack-mounting kit are optional. Approximately Gld 2500.

Philips, Industrial & Electro-acoustic Systems Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

Circle No 362

Philips Test and Measuring Instruments Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 363

VECTOR GENERATOR

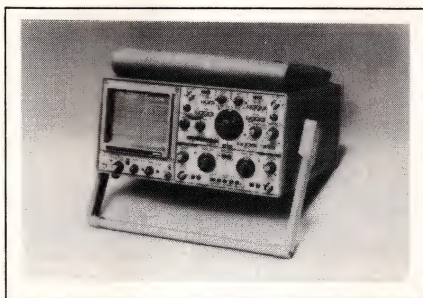
The Model HP 8780A vector signal generator accepts both digital bit streams and conventional analog signals as modulation inputs. Its clock rates range from dc to 150 MHz in clocked mode and from dc to 50 MHz in asynchronous mode. The instrument's frequency range is 10 MHz to 3 GHz. The generator also processes in-phase and quadrature analog modulation signals ranging from dc to 350 MHz. In addition, you can amplitude-modulate the output with a scalar (nonvector), 500-kHz AM signal or a 50-MHz (p-p) FM signal. The generator's synthesized carrier has a resolution of 1 Hz. Its output spans +10 to -100 dBm. \$55,000. Delivery, 12 weeks ARO.

Hewlett-Packard Co, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

Circle No 365

PORTABLE SCOPES

The SS-6122 100-MHz and SS-6611 60-MHz portable oscilloscopes each have a 6-digit reciprocal counter. Each of the 4-channel scopes also has four on-screen cursors. The cursors can automatically track the 10 to 90% excursions of a waveform. Besides displaying the usual measurement readouts, the screen can



show comments, such as the measurement setup, the contents, and the operator's name. The comments can be as long as 80 characters. The screens also show the date and time. The scopes can display ratiometric measurements referenced to previously entered voltage and time values. SS-6122, \$2295; SS-6611, \$1795.

Iwatsu Instruments Inc, 430 Commerce Blvd, Carlstadt, NJ 07072. Phone (201) 935-5220.

Circle No 364

SOFTWARE ANALYZER

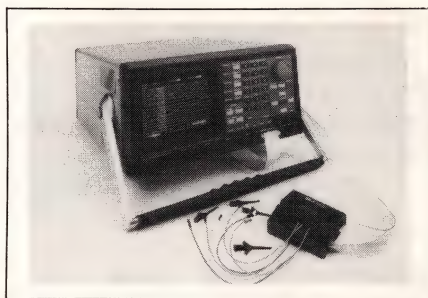
The OptiLab Microprocessor Development Toolbox integrates the company's emulator and bus analyzer with software-performance analysis. The ROM emulator works with more than 150 μ Ps. When analyzing software performance, you can count and time-tag software events in real time at full speed. The analysis software displays the results of the performance analysis on the screen of an IBM PC (you need a PC both to control the emulator and to run the analysis software). The 32k-byte version costs \$5980.

Orion Instruments Inc, 702 Marshall St, Redwood City, CA 94063. Phone (415) 361-8883. TLX 530942.

Circle No 366

LOGIC ANALYZER

You can configure the Compact-100 logic analyzer to have 32 input channels operating at clock rates to 25 MHz, 16 channels operating to 50 MHz, or 8 channels operating to 100 MHz. The external clock inputs accept clock frequencies as high as 25



MHz, and you can perform synchronous and asynchronous clocking simultaneously on different channels. The unit provides glitch detection on 16 input channels. Its trace memory is 1000 bits/channel in 32-channel mode and 2000 bits/channel in 16- or 8-channel mode. The analyzer has equivalent amounts of reference memory. Both the trace and the reference memories have battery backup.

It provides 4-level sequential triggering for trigger words based on the 32 data inputs and 8 trigger qualifiers. You can store as many as six front-panel setups in the nonvolatile memory. The instrument comes with IEEE-488 and RS-232C interfaces. Probe adapters are available for a range of popular 8- and 16-bit μ Ps. The Compact-100 measures 45 \times 40 \times 19 cm and weighs less than 10 kg. DM 9980.

Dolch Logic Instruments GmbH, Justus-von-Liebig-Strasse 19D, 6057 Dietzenbach, West Germany. Phone (06074) 40020. TLX 4191550.

Circle No 367

Dolch Logic Instruments Inc, 2029 O'Toole Ave, San Jose, CA 95131. Phone (408) 945-1881. TWX 910-338-2023.

Circle No 368

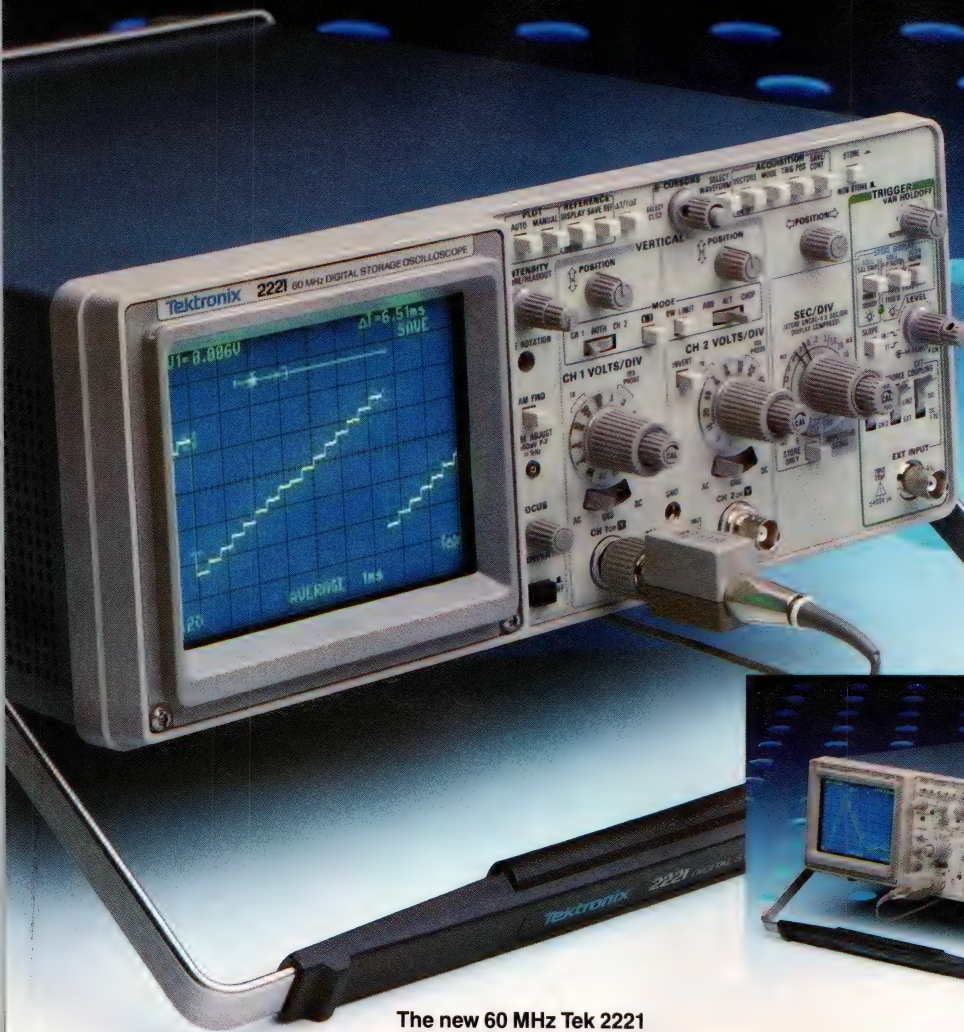
PULSE GENERATOR

The PM 5785 pulse generator has a pulse-repetition rate of between 1 Hz and 125 MHz, and it offers a choice of fixed 2-, 1.5-, or 1-nsec rise times. You can select bipolar or positive- or negative-going pulses in any of four amplitude ranges between 0.2 and 5V. The unit generates pulses from two complementary

Text continued on pg 287

EDN July 23, 1987

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The new 60 MHz Tek 2221 (above) offers such features as CRT readout and measurement cursors for just \$3995.



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CRT readout and cursors distinguish the new 2221. For even higher performance, there's the 100 MHz, dual time base 2230 with optional battery-backed

Features	2230	NEW! 2221	2220
Analog/Digital Storage BW	100 MHz	60 MHz	60 MHz
Maximum Sampling Speed	20 MS/s	20 MS/s	20 MS/s
Record Length	4K/1K (selectable)	4K	4K
Peak Detect	100 ns	100 ns	100 ns
Save Reference Memory	One, 4K Three, 1K	One, 4K	One, 4K
Vertical Resolution	8 bits 10 bits (AVG mode) 12 bits (AVG mode over the bus)	8 bits 10 bits (AVG mode)	8 bits
CRT Readout/Cursors	Yes	Yes	No
GPIB/RS-232-C Options	Yes (\$750)	Yes (\$500)	Yes (\$500)
Battery-Backed Memory (save 26 waveform sets)	Yes (inc with GPIB/RS-232-C)	No	No
Warranty	3 year on labor and parts, including the CRT		
Price	\$4995	\$3995	\$2995

memory for saving up to 26 waveform sets. And if it's economy you want, choose the 60 MHz 2220 with many of the same features at an even lower cost.

With each scope you can automate measurements with interface options. And output direct to a printer or plotter. Tek software is available for systems.

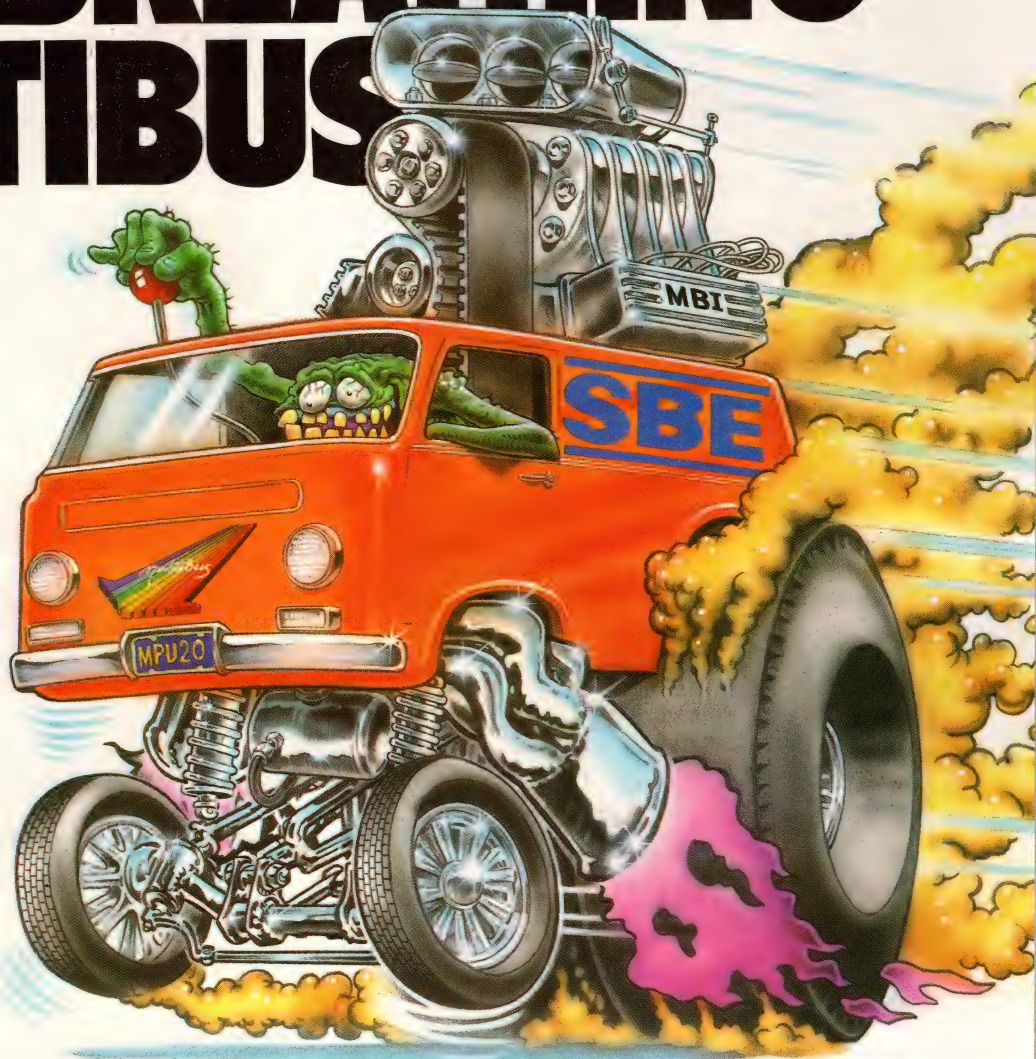
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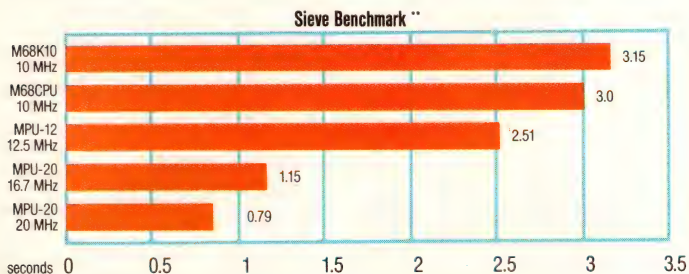
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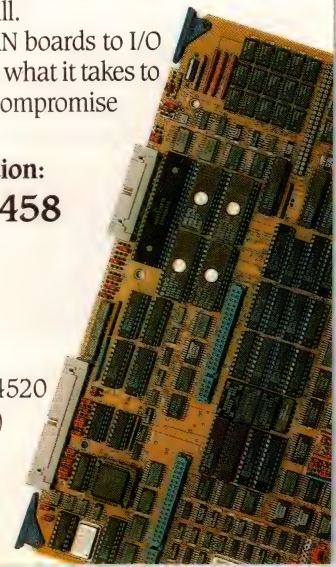
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CIRCLE NO 70



Instruments

outputs, and impedance back-matching absorbs more than 95% of signal reflections caused by mismatched loads. You can control pulse triggering, duration, and gating from external sources. External-trigger slope and level controls allow you to synchronize pulse generation to an external clock; external gating allows you to generate bursts of pulses. A burst-mode option provides programmable pulse bursts containing one to 9999 pulses. \$3385.

Philips, Industrial & Electro-acoustic Systems Div, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

Circle No 369

Philips Test and Measurement Instruments Inc, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 370

LOGIC ANALYZER

The PLA286 logic analyzer's mainframe accepts two 8-channel timing modules and two 48-channel state/timing modules to provide as many as 16 100-MHz timing channels and 96 20-MHz state/timing channels. The instrument doesn't make trade-offs between speed and number of channels, so you can use the full complement of timing and state channels together. The timing analyzer's triggering facilities include a window trigger mode that allows you to specify time periods (over the range from 30 nsec to 12.5 μ sec) between sequential trigger events. The analyzer's triggering also includes an event-duration filter, which allows you to search for trigger events that are longer or shorter than a defined period (in the range from 10 nsec to 12.5 μ sec).

The 100-MHz channels have a trace-memory depth of 8000 words, and the 20-MHz channels have a memory depth of 4000 words. The analyzer is based on the company's IBM PC/AT-compatible computer,

so it can run commercial software packages under MS-DOS. From around DM 15,000 to DM 31,000, depending on configuration.

Kontron Messtechnik GmbH, Oskar-von-Miller-Strasse 1, 8057 Eching, West Germany. Phone (08165) 77541. TLX 526719.

Circle No 373

Kontron Electronics Inc, 633 Clyde Ct, Mountain View, CA 94039. Phone (415) 965-7020. TWX 910-378-5207.

Circle No 374

GAIN-PHASE METER

The 1253 gain-phase analyzer operates over the frequency range of 1 mHz to 20 kHz and measures gain and phase to an accuracy of 0.1 dB and 1.0°, respectively, on a 4-digit display. The instrument rejects the harmonic components in the response of nonlinear systems, letting the instrument accurately measure the fundamental component of a signal even when it is buried in noise. The unit's nonvolatile memory allows you to program a sequence of measurement setups, which you can protect against alteration by operating a keyswitch. The analyzer provides long-term storage for as many as 400 test results, and it comes with an IEEE-488 remote-control interface. £4800.

Solartron Instruments, Victoria Rd, Farnborough, Hampshire GU14 7PW, UK. Phone (0252) 544433. TLX 858245.

Circle No 371

Solartron Instruments Inc, 2 Westchester Plaza, Elmsford, NY 10523. Phone (914) 592-9168. TLX 145487.

Circle No 372

RF GENERATOR

The PSG1000 RF-signal generator covers the frequency range from 10 kHz to 1 GHz. Its resolution is 10 Hz below 128 MHz, and 100 Hz above 128 MHz. The generator's output

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LEADER SWEEPSTAKES
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Hauppauge, NY 11788

CIRCLE NO 50

Instruments



level is variable in the range from 0.05 μ V to 1V, and because the instrument does not use frequency doublers to produce its high frequency ranges, its output is not corrupted by subharmonics. The basic unit's modulation capabilities include amplitude, frequency, and phase modulation; pulse modulation is optional.

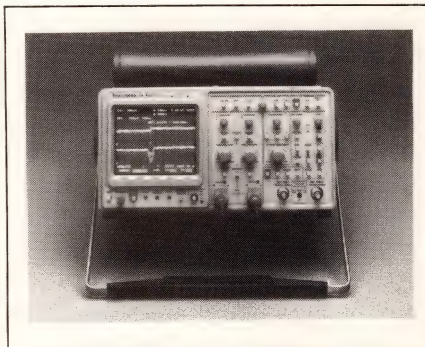
Besides providing 1-kHz fixed-tone modulation, the PSG1000 has an audio-frequency synthesizer that generates modulation frequencies between 10 Hz and 10 kHz. It also has an external modulation input, which you can de-couple. You can select multiple modulation unsquelching tones to test CTCSS, CCIR, EEA, ZVEI-1/2, EIA, NATEL, and SECALL systems. The unit's built-in sinad meter simplifies receiver-alignment checks. Its nonvolatile memory allows you to store front-panel setups. It comes with an IEEE-488 remote-control interface; control via a handheld calculator is optional. The PSG100 operates from line supplies or from 12V (or optional 24/28V) dc supplies. £3250.

Farnell International Instruments Ltd, Sandbeck Way, Wetherby, West Yorkshire LS22 4DH, UK. Phone (0937) 61961. TLX 557294.

Circle No 375

DIGITAL SCOPE

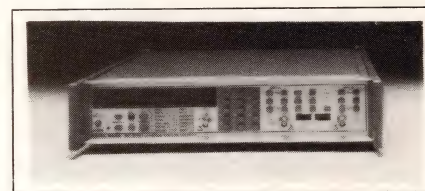
The 2430A digital oscilloscope includes two 100M-sample/sec digitizers having 8-bit resolution. The unit has a 2-nsec glitch-capture feature as well as 1k samples/channel of capture memory. The scope has an



automatic-setup feature, and it can extract 21 waveform parameters from a captured signal. You can program the scope to go through a series of setups. The unit can babysit a circuit under test and record events that fall outside specified limits. \$8900.

Tektronix, Box 1700, Beaverton, OR 97075. Phone (800) 426-2200; in OR, (503) 627-9000.

Circle No 376

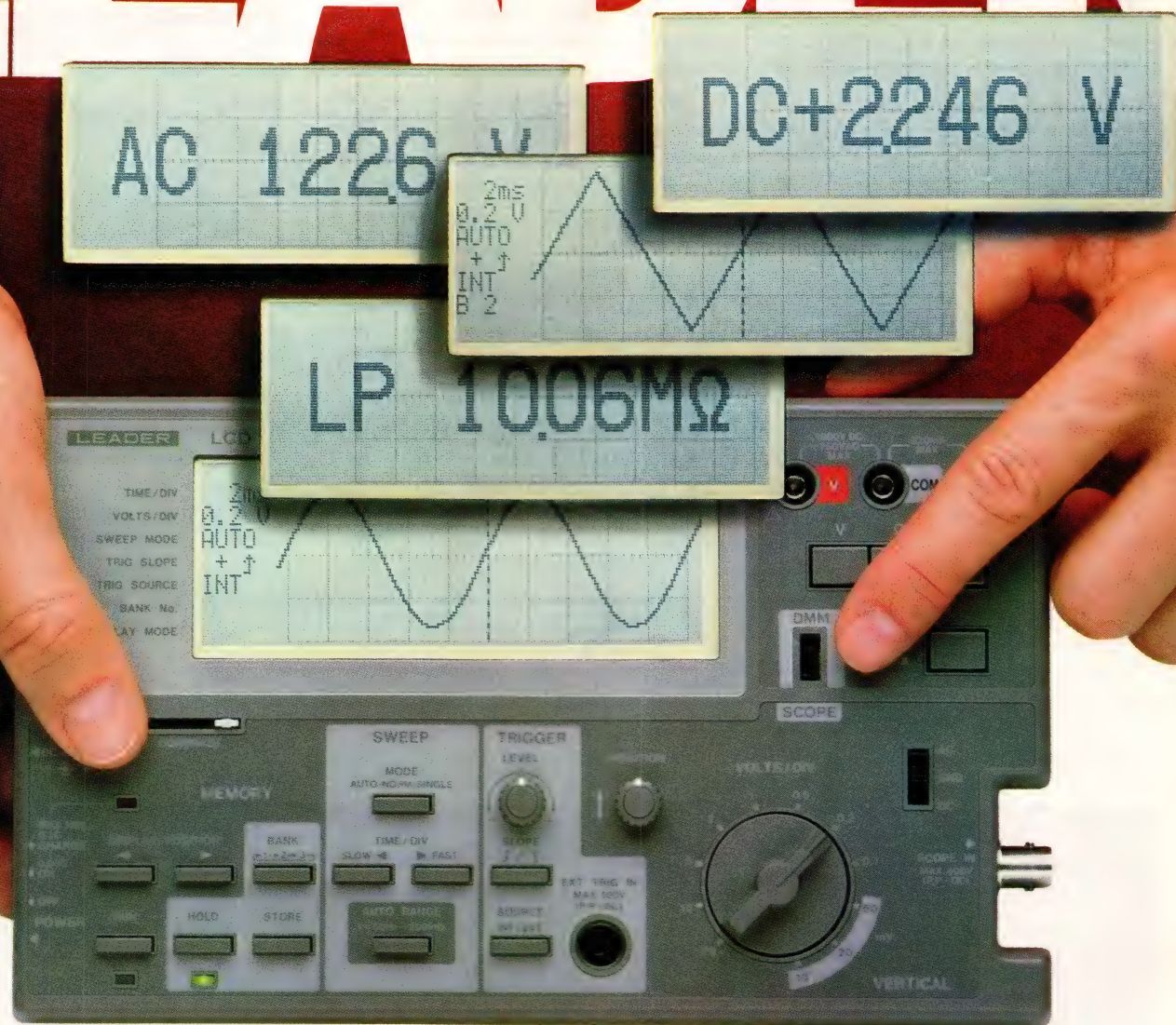


COUNTER

The Model 1995 universal counter/timer is the first commercially available instrument having an optional rubidium timebase oscillator. The oscillator offers an aging rate of $<5 \times 10^{-11}$ parts per month or $<2 \times 10^{-7}$ parts per year. The unit measures to nine digits in one second and covers the frequency range from dc to 200 MHz. Its input sensitivity is 50 mV. Its frequency accuracy is 400 times better than that of crystal timebases, the vendor claims. The unit can make as many as 150 readings/sec when it's on the IEEE-488 bus. A MATE interface is optional. Model 1995 with optional rubidium timebase, \$11,250. Delivery, 12 weeks ARO.

Racal-Dana Instruments Inc, Box C-19541, Irvine, CA 92713. Phone (714) 859-8999. TWX 910-595-1136.

Circle No 377



Portable Problem Solver

Ultra-compact Digital Storage Oscilloscope-Multimeter.

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DEVELOPMENT SYSTEM

The KPDS can act as a stand-alone portable software-development system or as a universal emulator workstation when interfaced to a mini-computer. The unit has a 616k-byte (formatted) floppy-disk drive and an integral 17.5M-byte (formatted) Winchester disk that stores program-development utilities. You can increase its program-assembly speed by adding an optional 1M-byte RAM disk. The emulator supports most 8- and 16-bit μ Ps at their full system-clock frequencies; to adapt to each μ P, it requires a plug-in personality card and a new probe. You can expand the emulation memory to 128k bytes, and you can map memory between the emulator and the target system in 256-byte blocks. The emulator's memory-management unit allows you to simulate paged memory.

The emulator provides four hardware breakpoints (for program or

data); you can logically combine complex conditions for each breakpoint, including the conditions of three external signal inputs. You can also daisy-chain as many as four emulators to emulate multiprocessor systems. Options for the emulator include a 64-channel, 256-word trace analyzer. Approximately \$13,000.

**Kontron Messtechnik GmbH,
Oskar-von-Miller-Strasse 1, 8057
Eching, West Germany. Phone
(08165) 77551. TLX 526719.**

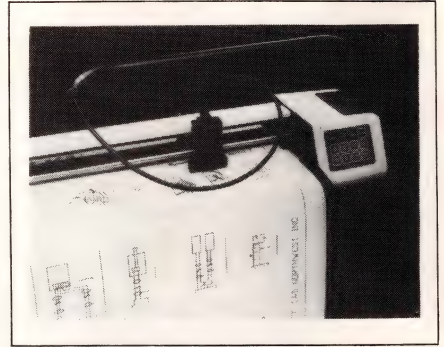
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**Kontron Electronics Inc, 630
Clyde Ave, Mountain View, CA
94039. Phone (800) 227-8834; in CA,
(415) 965-7020. TWX 910-378-5207.**

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The Scan-Cad is a 200-dot/in. scanning head that you can add as an



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Houston Instrument, 8500



HAMEG Instruments

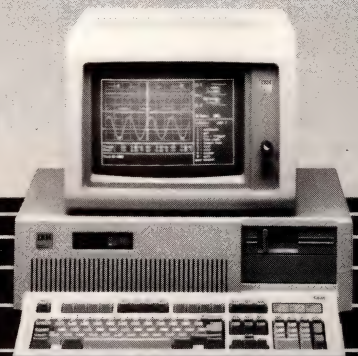
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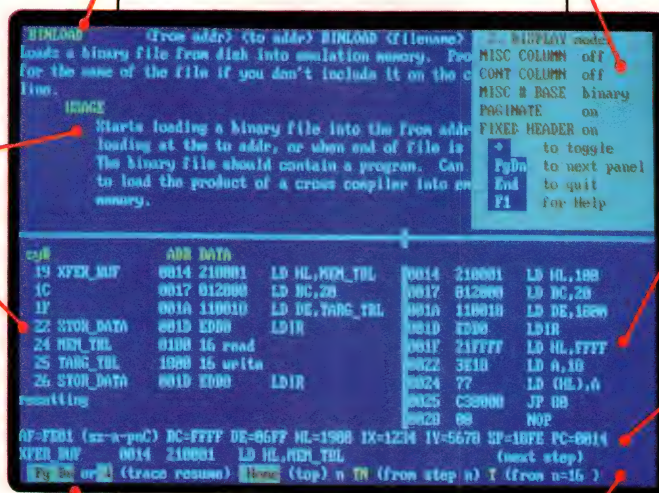
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Searching for bugs by single-stepping through suspect code can take forever. Now, with UniLab, just specify the bug symptom you are looking for as a trigger spec and let UniLab catch the

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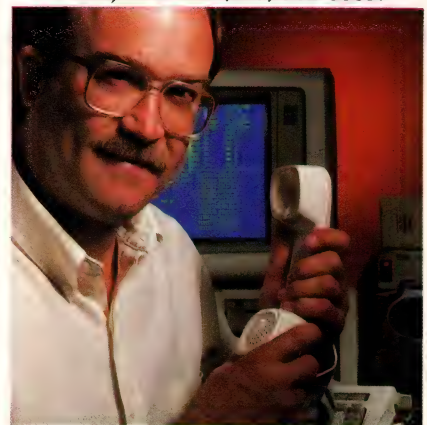
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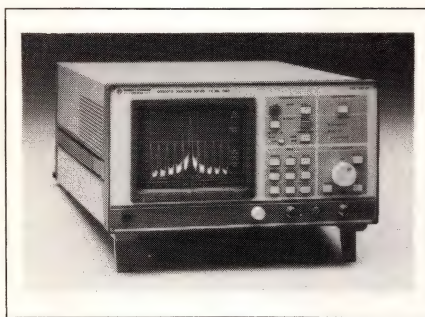
Circle No 381

80286 DEBUGGER

The iRMX 286 version of the company's Soft-Scope 80286 debugger provides full support for the 80286's protected mode, including the handling of hardware-protection traps. The source-level debugger can run programs written in C, Pascal, Fortran, assembly language, and Intel's PL/M. It displays all variable types including Pascal records, PL/M and C structures, multidimensional arrays, and real types. Other versions of the debugger run under the MS-DOS, Isis, and iNDX operating systems. You can also obtain a version that works with Applied Microsystems' (Redmond, WA) ES 1800 in-circuit emulators. \$1000 to \$1500.

**Concurrent Sciences Inc, Box
9666, Moscow, ID 83843. Phone
(208) 882-0445. TLX 4942758.**

Circle No 378



ANALYZERS

The Model FSAL and FSAP analyzers cover 100 kHz to 1.8 GHz and operate to 1 kHz with reduced specifications. Model FSAL is a spectrum analyzer; Model FSAP is a combination spectrum and scalar network analyzer. Both products offer a color display, μ P architecture, and functions that you can program via the IEEE-488 bus. Internal firmware lets you print measurement and setup configurations

on a digital plotter via the IEEE-488 bus without an external controller. Both units offer balanced mixer inputs for sensitivity of at least -120 dBm, harmonic measurement to -70 dBc, and intermodulation to -65 dBc. \$14,900 for the FSAL; \$17,900 for the FSAP.

**Rohde & Schwarz-Polarad Inc, 5
Delaware Dr, Lake Success, NY
11042. Phone (516) 328-1100. TWX
510-223-0414.**

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DEVELOPMENT SYSTEM

This 16-MHz μ P-development system integrates software development, in-circuit emulation, logic-state tracing, and EPROM programming. You use the CTS51 system with an IBM PC or a compatible computer. It handles development tasks for such 8-bit NMOS and CMOS processors as Intel's 8051 and 8751; Siemens' 80515 and 80535; and Oki's 80C31, 80C51, and 80C59. Adding a personality board allows the system to support other 8-bit units. A typical system costs \$5995.

**Ashling Microsystems Inc, 542
Lakeside Dr, Suite 2, Sunnyvale,
CA 94086. Phone (408) 720-9131.**

Circle No 383

MAC/488 INTERFACES

Two interface products provide a GPIB connection for Macintosh computers. The first product, the NB-GPIB board, works with the Macintosh II. When used alone, the board acts as a programmed I/O interface that allows data transfer between the Macintosh II and EIII 488-compatible instruments via the PC Nubus. When used with the company's Real-Time System Integration (RTSI) bus, the board handles DMA transfer at as much as 1M bps.

Another interface, the IEEE-488 bus SE card, contains circuitry to connect the Macintosh SE and its 68000 μ P to the IEEE-488 bus. The

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**TURN TO
PAGE 341**

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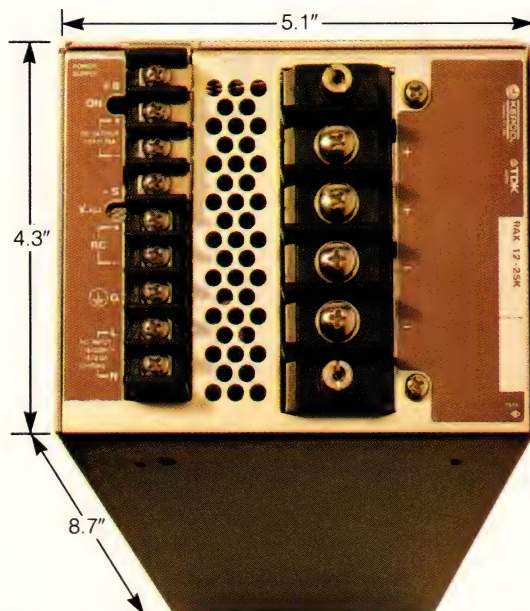
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interfaces cost \$495 each. In addition, the IEEE-488 bus SE card offers options—it costs \$795 with DMA, \$995 with a math coprocessor, and \$1295 with both DMA and the coprocessor.

National Instruments Corp.
12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488.

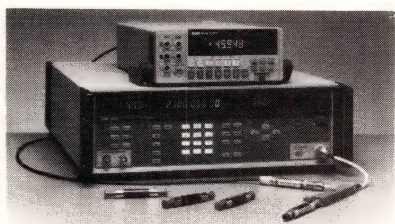
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SYNTHESIZER

This digital frequency synthesizer (called the Williams Synthesizer after its creator, TRW's Fred Williams) provides 0.5V p-p into a 75Ω load with almost no phase noise, according to the company. The unit has a usable frequency range of 1 Hz to >6.5 MHz. Its frequency resolution is 1 Hz, and its output is phase continuous. The synthesizer and an accompanying controller come on stackable 4×5-in. circuit boards. You can order keyboards, displays, blank circuit boards in kit form, or assembled and tested units. The bare-board price of the RF units and controller is \$17.50 each.

A&A Engineering, 2521 W La Palma, Unit K, Anaheim, CA 92801. Phone (714) 952-2114.

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The 6062A synthesized-frequency generator handles L-band applications from 0.1 MHz to 2.1 GHz. The instrument's pulse modulator uses GaAs-switch technology to provide rise/fall times of 15 nsec and on/off ratios of 80 dB. These rise/fall times permit <50-nsec pulses. You can adjust the generator's output level

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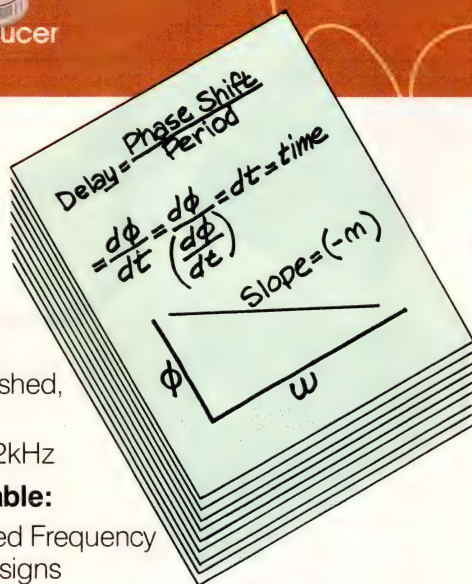
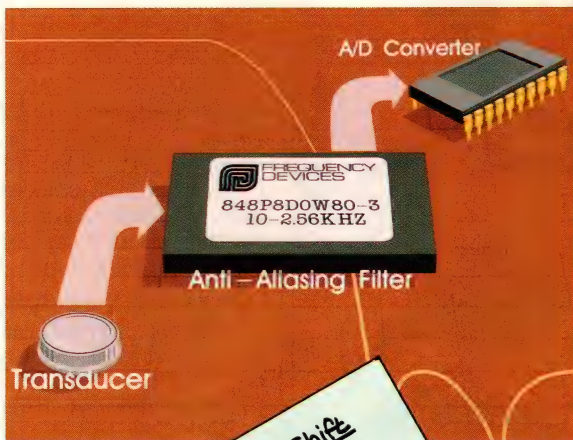
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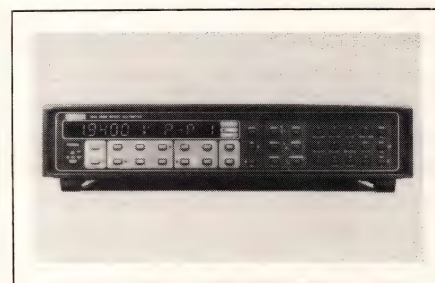
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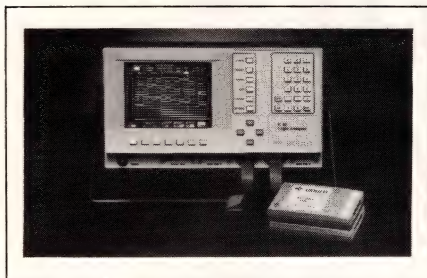


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Gould Inc, Test & Measurement Group, 19050 Pruneridge Ave, Cupertino, CA 95014. Phone (800) 538-9320.

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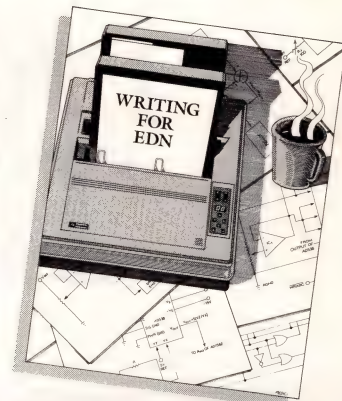
OSCILLOSCOPES

Each of these oscilloscope models has an 8×10-cm CRT display with an internal graticule. Models V-1065 and V-1060 have 100-MHz bandwidths; Models V-665 and V-660 have 60-MHz bandwidths. All the models provide on-screen read-outs of sweep rates and delay time. They also feature trigger locking, automatic continuous sweeping, and TV triggering. The scopes measure <11×14×5 in. and weigh about 13 lbs. Two of the models (V-1065 and V-665) offer cursor measurement to read such parameters as voltage difference, time difference, and frequency. \$1095 to \$1795.

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**TURN TO
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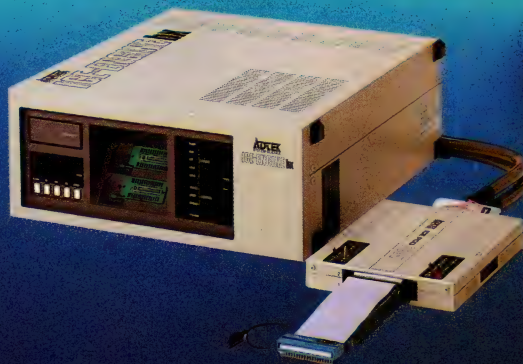
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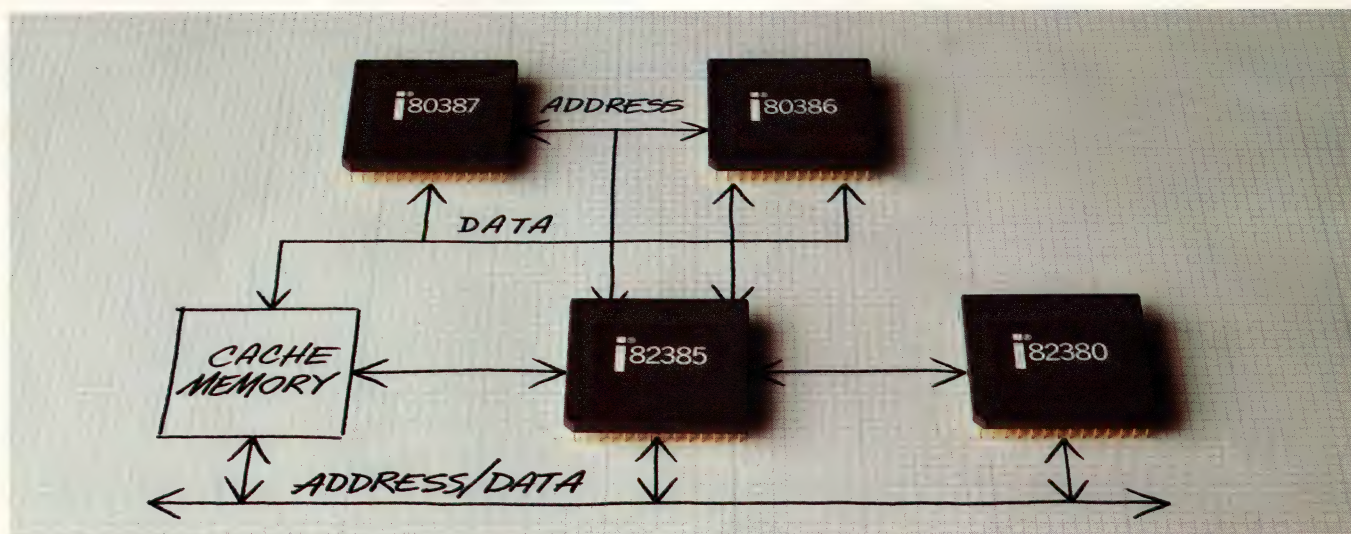
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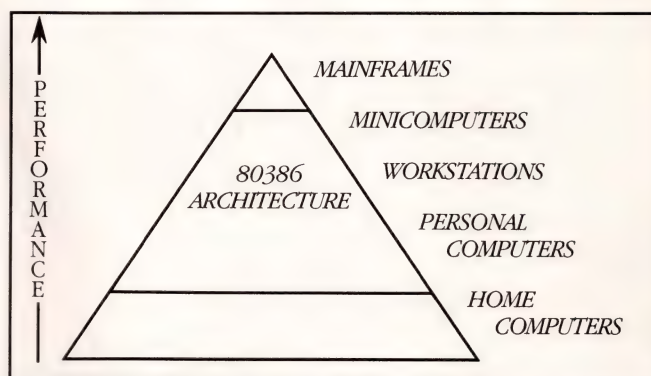
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*Convergent Technologies Server/PC with 20 MHz 80386. UNIX System V Release 3 0.S. Green Hills C Compiler version 1.82F.

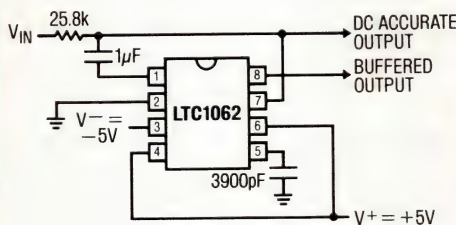
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CIRCLE NO 197

DESIGN IDEAS

EDITED BY TARLTON FLEMING

Differential Rx/Tx uses all NAND gates

Paul Reilly

Kaiser Electronics, San Jose, CA

Fig 1 is a differential data-transmission system in which the receiver and transmitter (Rx/Tx) circuits consist of only NAND gates. By implementing these circuits in a PLA or a gate-array IC, you can derive the benefits of differential transmission without using differential line drivers and receivers.

The transmitter simply converts a single-ended pulse stream into differential Q and \bar{Q} signals. The receiver

reconstructs the transmitted data by converting these signals back to a single-ended format. In doing so, the receiver votes against (ignores) any input for which both lines have the same logical state. This condition exists for one gate-delay interval following each transition of the input signal. Noise can also produce this same-state condition; the receiver completely rejects such noise.

EDN

To Vote For This Design, Circle No 750

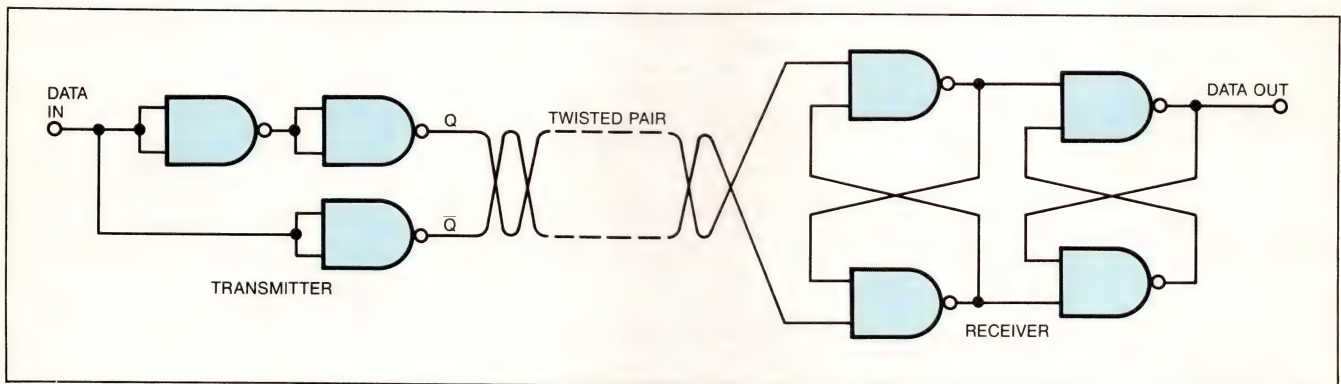


Fig 1—You can implement this all-NAND-gate differential data-transmission system in a PLA or a gate-array IC.

VLSI-chip functional tester costs \$50

Kurt Witte

Ciprico Inc, Plymouth, MN

The functional tester in **Fig 1** is suitable for testing VLSI chips such as gate arrays and standard-cell ICs, and the parts that make up the circuit cost less than \$50. You store the required test vectors in EPROMs. The latch IC that buffers the output of each EPROM prevents glitches caused by changes at the EPROM's address inputs. Each latch output drives an 8-bit digital comparator (Am25LS2521) and an octal buffer (74LS244), which in turn drives the device under test. On command, the Am25LS2521 ICs compare outputs from the chip under test with those expected from a good chip.

Any discrepancy between actual and expected results will ripple down the chain of cascaded comparators and set the error flip-flop (IC₁). The flip-flop's Q output indicates a bad chip by turning on the red LED; the \bar{Q} output indicates a good chip by turning on the green LED.

To prevent the electrical damage that might occur if you inserted the device under test into an energized test socket, the "test" pushbutton applies power to the chip only during the test. Following closure of the pushbutton, the 555 timer (IC₅) initiates the test by resetting the cascaded counters, IC₂, IC₃, and IC₄, and the error flip-flop. The counters then generate 11-bit address words that scan through all the EPROM locations in sequence. (A spare bit in one of the EPROMs

DESIGN IDEAS

indicates the end of the test sequence by asserting the **DONE** signal.)

The 2716-type EPROMs shown are suitable for any application that requires fewer than 2048 test vectors. To provide more vectors, you must use larger EPROMs and a larger counter. Moreover, if your chip has more

than 63 input and output signals, you must include more EPROMs, latches, and comparators. **EDN**

To Vote For This Design, Circle No 748

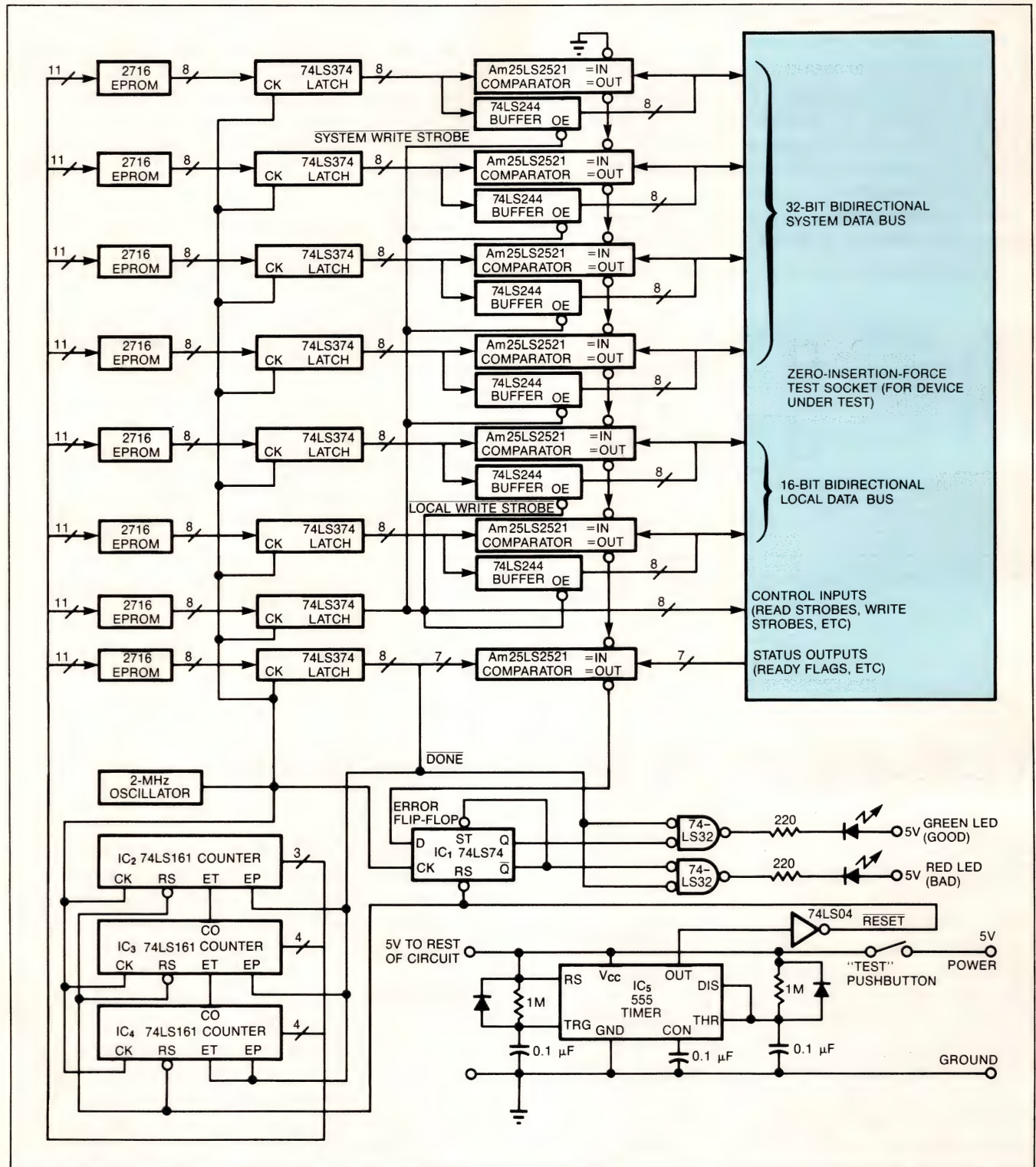


Fig 1—This functional tester for digital LSI chips holds as many as 2048 test vectors and tests as many as 63 input and output signals.

Audio AGC circuit has 40-dB dynamic range

Norman M Hill
Zetron Inc, Bellevue, WA

The automatic-gain-control (AGC) circuit of **Fig 1a** operates on $\pm 5V$ supplies and provides good fidelity for audio signals over an input range of 40 dB. The circuit maintains an output of 0 dBm ($\pm 1.1V$) by varying the input attenuation from 0.1 to 10 (-20 to 20 dBm).

JFET Q_1 operates as a variable resistor. Q_1 and resistor R_1 divide the input signal in response to the control voltage on the gate of Q_1 . Op amp IC_{1A} (with R_4 and R_5) then provides enough gain to accommodate input signals of ± 20 dBm (**Fig 1b**).

To ensure low distortion in a JFET, you should add approximately one-half the drain-source voltage to the gate voltage. The voltage divider (R_2/R_3) and the buffer

amplifier (IC_{1B}) provide this gate bias by charging and discharging capacitor C_2 . R_8 isolates the gate-source diode in Q_1 .

The peak-detector amplifiers (IC_{1C} and IC_{1D}) have a gain of 20. Their outputs reside at negative-saturation levels when V_{OUT} is between 1.1 and -1.1V; the resulting Q₁ gate voltage (-4V) allows maximum circuit gain. When V_{OUT} makes an excursion outside this range, one of the peak-detector outputs rises in the positive direction, discharging C₂ and driving Q₁'s gate in a more positive direction. Thus, Q₁ regulates the output by increasing the input-signal attenuation. C₂ discharges through the attack resistor, R₆, until the output level returns to 0 dBm. When the input level subsides, C₂ slowly recharges through the decay resistor, R₇. For a 20-dBm change, the attack time is 5 msec and the

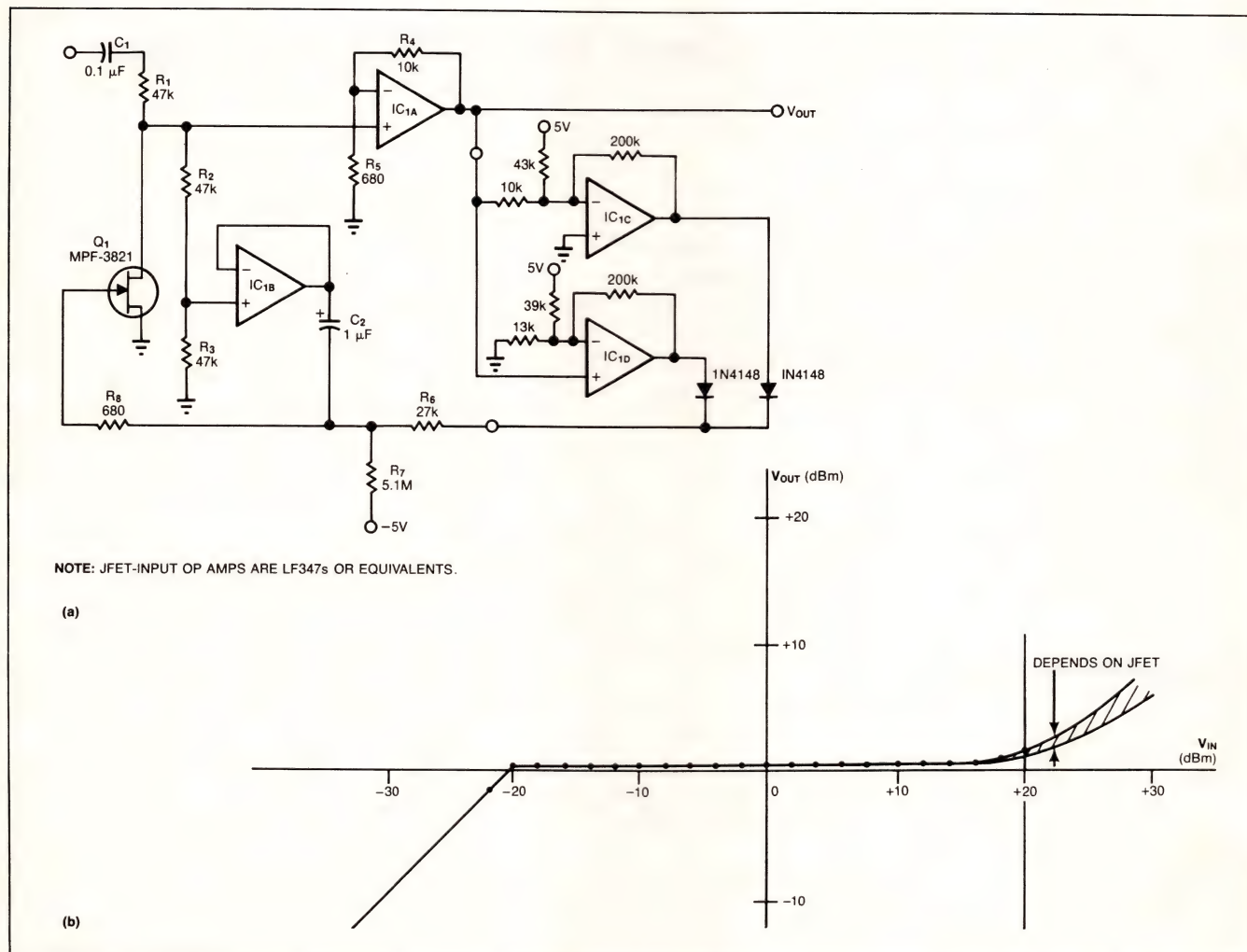


Fig 1—Using a JFET to control input attenuation, this AGC circuit (a) provides a dynamic range of ± 20 dBm (b).

DESIGN IDEAS

decay time is 1 sec.

For a small sacrifice in audio quality, you can reduce the parts count by substituting a simplified peak detector (Fig 2). The simpler circuit causes a faint buzzing, but this noise is audible only with some stereo equipment.

You can also shift the 40-dBm gain range. Changing R_4 to 30 k Ω , for example, sets the range from -30 to 10 dBm. (With the higher gain, you need a capacitor in series with R_5 to prevent excessive voltage offset.) Because the noninverting input of op amp IC_{1A} is noise-sensitive, it should be physically small and remote from the noisy peak-detector outputs.

EDN

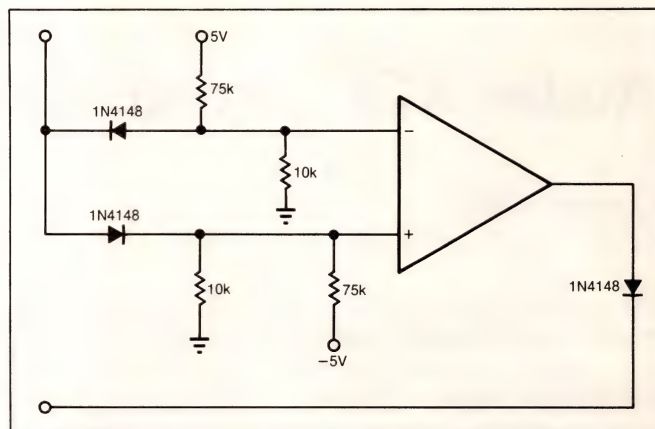


Fig 2—You can save parts by using this peak detector in the Fig 1 circuit.

To Vote For This Design, Circle No 747

Programmable regulator has clean response

Robert A Pease

National Semiconductor Corp, Santa Clara, CA

For the resistor values shown, the adjustable regulator of Fig 1 provides an output of either 22 or 5V, depending on the state of V_{CONTROL} (0 or 5V). Moreover, the output's linear, symmetrical rise and fall times are useful when programming EPROMs and EEPROMs.

Resistors R_1 , R_2 , and R_3 determine V_{OUT} . When $V_{\text{CONTROL}}=0\text{V}$,

$$V_{\text{OUT}} = 1.25 \left(1 + \frac{R_2}{R_1} \right).$$

When $V_{\text{CONTROL}}=5\text{V}$,

$$V_{\text{OUT}} = 1.25 \left(1 + \frac{R_3/R_2}{R_1} \right).$$

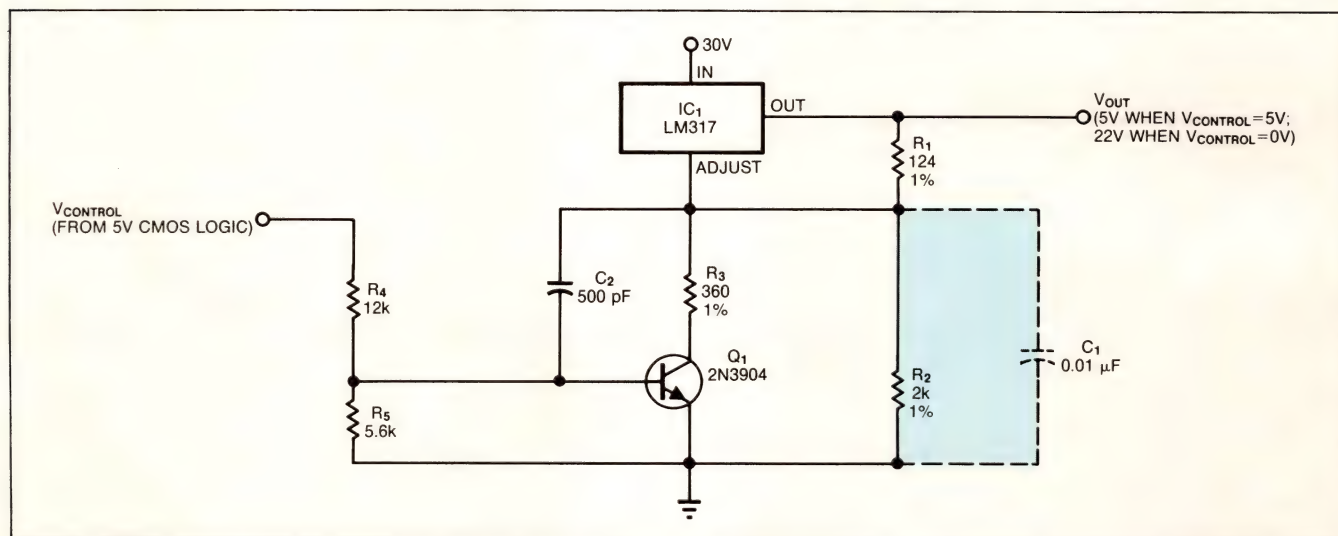


Fig 1—Depending on V_{CONTROL} , this positive regulator has two available outputs.

DESIGN IDEAS

With C_1 (indicated by dashed lines in Fig 1) taking the place of capacitor C_2 , the 20- μ sec time constant R_2C_1 determines the output rise time, and the time constant R_3C_1 sets a faster fall time—perhaps too fast (Fig 2a).

When you connect C_2 instead of C_1 , transistor Q_1 becomes a Miller integrator and produces an improved response (Fig 2b). In particular, the positive slew rate remains constant to within 1V of the final level, and Fig 2b's waveform settles more quickly than that of Fig 2a.

The indicated values for R_4 and R_5 set symmetrical slew rates for a 5V CMOS-logic signal; different values can produce slew rates compatible with TTL or other logic families. (Slew rates vary with moderate changes in the ambient temperature, but this won't be a problem in most instrument applications.) **EDN**

To Vote For This Design, Circle No 746

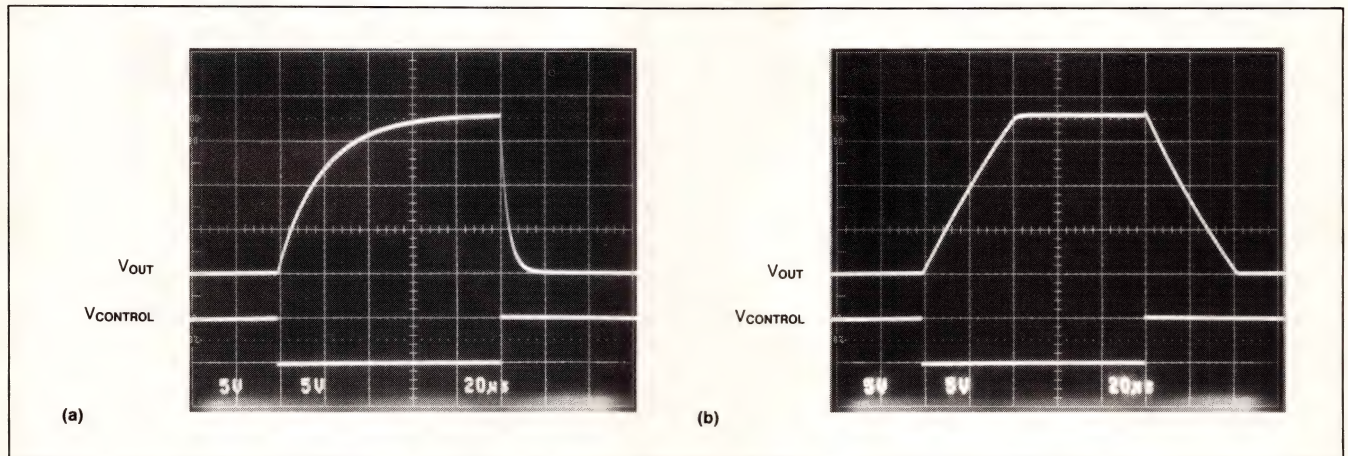


Fig 2—Fig 1's output response with C_1 in place and C_2 removed (a) shows nonlinear, asymmetrical rise and fall times and a slow-settling positive transition. With C_2 in place and C_1 removed (b), the circuit's slew rates are linear, and the positive transition settles more quickly. For both photos, the vertical trace is 5V/div, and the horizontal trace is 20 μ sec/div.

JFET serves as low-power logic translator

Timothy R Wolf
Herley Microwave Systems, Lancaster, PA

Fig 1 shows a simple method for translating a 5V logic signal to the 12 or 15V level required by certain CMOS ICs. Transistor Q_1 is an n-channel JFET operating in the common-gate mode. A source voltage above 1 or 2V pinches the JFET's channel off and allows R_1 to pull the drain voltage to V_S . A source voltage near 0V turns the channel on, which places the drain near 0V as well.

R_1 determines the circuit's speed and power consumption. Values from 100 k Ω to 1 M Ω draw approximately 150 to 15 μ A and set a practical pulse-rate limit of about 1 MHz. This circuit consumes less power than one based on a bipolar transistor, and it does away with one part (the base resistor). **EDN**

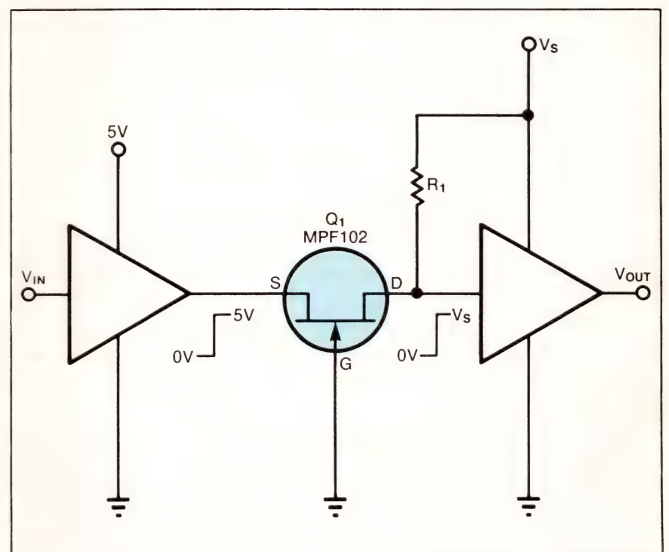


Fig 1—This JFET, operating in the common-gate mode, provides low-power translation of a 5V logic signal to higher voltage levels.

To Vote For This Design, Circle No 749

DESIGN IDEAS

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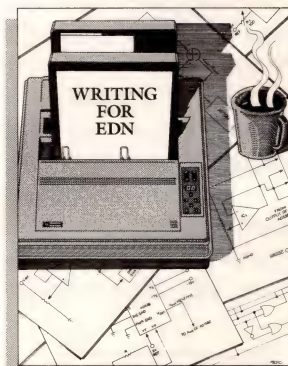
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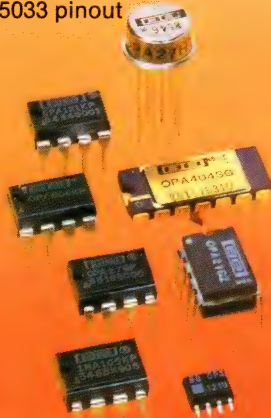
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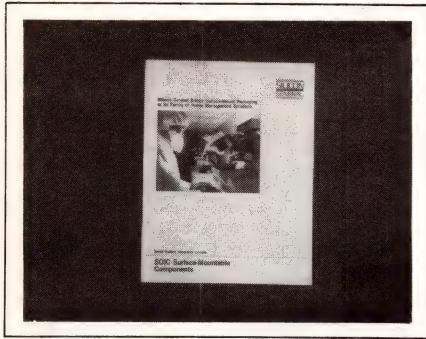
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LITERATURE: INTEGRATED CIRCUITS



Brochure addresses surface-mount ICs

This 4-pg brochure highlights the manufacturer's line of small-outline surface-mount ICs, particularly its PWM products. The pamphlet includes thermal characteristics, package dimensions, and packaging options, and it briefly discusses the benefits of the technology.

Silicon General, 11861 Western Ave, Garden Grove, CA 92641.

Circle No 648

Short-form catalog on VLSI products

This 8-pg catalog features the company's analog and digital VLSI products, such as A/D and D/A converters, multipliers, multiplier/accumulators, memory/storage products, and special-function products. The catalog also includes a list of packaging styles, with photos of the key packages.

TRW Electronic Components Group, LSI Products Div, Box 2472, La Jolla, CA 92038.

Circle No 649

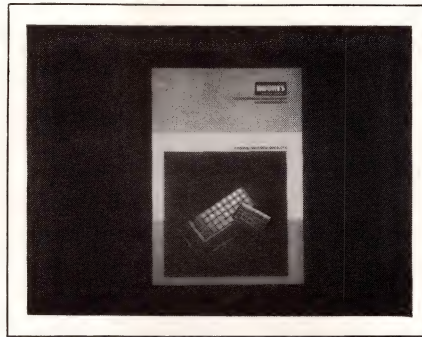
Brochure aids in selecting surface-mount packages

This brochure describes the different package sizes available for the company's CMOS special-function devices, as well as the ICs' capabilities. The products covered include A/D and D/A converters, PLL/frequency synthesizers, decoders, display drivers, smoke detectors, remote-control devices, op amps, and comparators. The brochure describes PLCC and small-outline

package structures and advantages. Request *Catalog BR503*.

Motorola Inc, Literature Distribution Ctr, Box 20912, Phoenix, AZ 85036.

Circle No 651



Microcircuits described

This 12-pg brochure covers the manufacturer's custom-design capabilities and line of hybrid microcircuits, including high-speed digital circuits, power hybrids, microwave and analog microcircuits, space hybrids, and advanced modules. It also discusses the vendor's packaging technology and computer-aided design and manufacturing capabilities in terms of the microcircuits featured.

Hughes Aircraft Co, Box H, Newbury Beach, CA 92658.

Circle No 654

Data on ASICs

These three pieces of literature provide an overview of the company's ASIC offerings. *The ASIC Continuum* gives a synopsis of available ASIC products, ranging from programmable logic devices to gate arrays to cell-based custom ICs. *ASIC Design: A Continuum of Alternatives* describes the various design-interface and design-tool options, including workstation libraries and personal-computer-based systems. *The 2-Micron Gate Array Databook* contains detailed design, applications, and data-sheet information for the manufacturer's line of CMOS gate arrays.

Gould Inc, Semiconductor Div,

3800 Homestead Rd, Santa Clara, CA 95051.

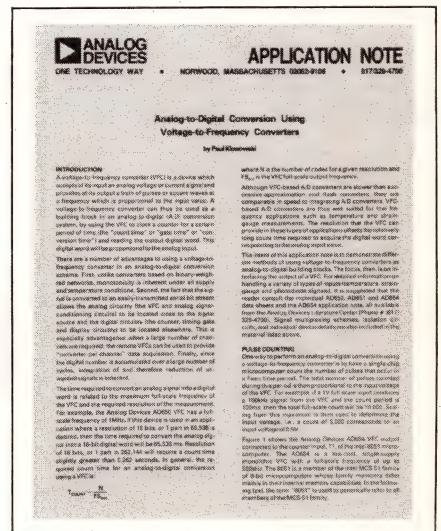
Circle No 653

Wall chart depicts PLDs

This wall chart provides a convenient reference to all types of programmable semiconductor devices. It's divided into sections that tabulate all PLDs, EPLDs, GALs, bipolar and CMOS PROMs, EPROMs, EEPROMs, and microprocessors. The information listed includes programmable-array size, the number of pins, and the company's identifier code for each device.

Stag Microsystems Inc, 3 Northern Blvd, Amherst, NH 03031.

Circle No 655



App note demonstrates A/D conversion scheme

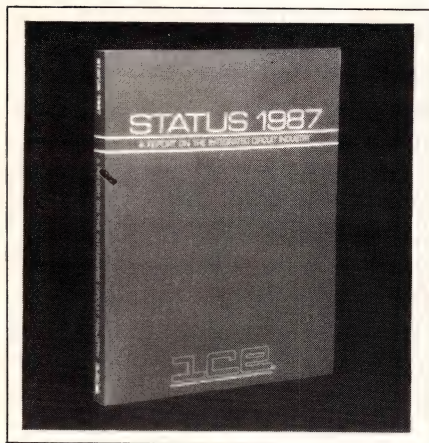
This application note, *Analog-to-Digital Conversion Using Voltage-to-Frequency Converters*, demonstrates several methods of using V/F converters as building blocks in an A/D conversion scheme. For instance, the document diagrams and discusses pulse-counting and period-timing techniques for interfacing with a 1-chip microcomputer. It also suggests possible sources of errors and solutions. It includes an illustration of the AD651 as a 16-bit-resolution A/D system.

Analog Devices, Literature Ctr,

LITERATURE

70 Shawmut Rd, Canton, MA 02021.

Circle No 652



Forecast for IC industry

Status 1987 is a comprehensive, annual review and forecast of the IC industry. The 250-pg book covers the current status and future trends of the industry and contains more than 200 tables. An appendix lists

the location and phone number of every known IC facility, as well as the companies that serve the IC industry (for example, wafer suppliers and test houses). \$275; \$295 international.

Integrated Circuit Engineering Corp, 15022 N 75th St, Scottsdale, AZ 85260.

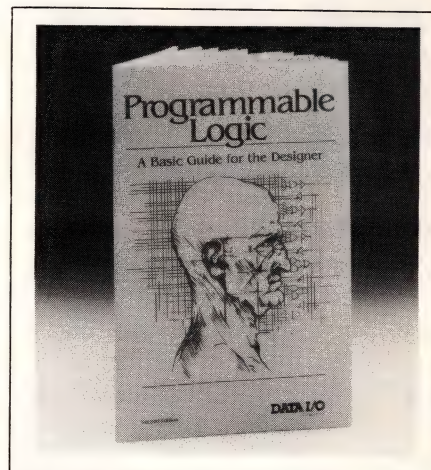
INQUIRE DIRECT

Brochure highlights family of modem ICs

This 8-pg brochure features the K Series, a family of pin-compatible, single-chip modem ICs. The 2-color booklet describes the characteristics of the four circuits and presents tables, charts, and graphs of supplemental data. One chart depicts a comprehensive software-register scheme for the family. Device pin-outs are included. The brochure also lists relevant design-application literature.

Silicon Systems, 14351 Myford Rd, Tustin, CA 92680.

Circle No 659



Booklet delves into programmable logic

This 30-pg booklet examines the topic of programmable logic. Sample chapters ask (and answer) such questions as "What is a program-

Color by

Watch Apple's new Macintosh II do for color computing what the original Macintosh did for black & white. Our RAMDAC enables Macintosh II to display some of the finest quality graphics available in a personal computer.

mable logic device?" and "Why was programmable logic developed?" The pamphlet also describes the different types of programmable logic devices and how to use the logic; it provides a design example. A glossary and references are included.

Data I/O Corp., Box 97046, Redmond, WA 98073.

Circle No 657

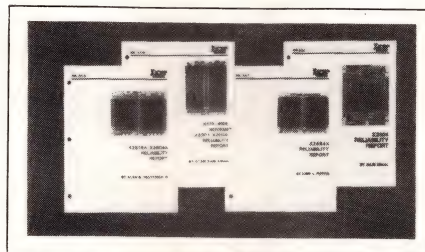
Set of books references products for 1987

These nine product handbooks are available separately or as a set. The books, which vary in price, cover such topics as memory components (\$18), embedded controllers (\$18), microcommunications products (\$20), microprocessors and peripherals (2-volume set, \$25), development tools (\$18), OEM boards and systems (\$18), military ICs (\$18), component quality and reliability (\$20), and system quality and reliability (\$20).

bility (\$20). The complete set costs \$125. In the US and Canada, add 10% for postage (20% foreign) and, if necessary, local sales tax.

Intel Corp., Box 58065, Santa Clara, CA 95052.

INQUIRE DIRECT



Four reports on memories

Brochures *RR-505*, *RR-506*, *RR-507*, and *RR-508* contain technical information and test results on the company's nonvolatile RAMs and EEPROMs. The reports describe the stresses used to establish reliability data; review the technology used in producing the

EEPROMs; explain why you can expect excellent data retention; and provide failure-rate predictions.

Xicor Inc., 851 Buckeye Ct, Milpitas, CA 95035.

Circle No 656

App note examines trimming of monolithic chip

Wafer Level Trim of Monolithic Digital-to-Analog Converters, a 4-pg application note, discusses the factors to keep in mind when you're trimming a chip that contains most of the active components of a D/A converter. The document presents a detailed analysis of different types of trimming (Vapox, laser, mechanical, and resistor) and describes the mounting of wafers in fixtures as well as the required software organization. In conclusion, the note concedes that, although wafer-level active trimming of monolithic devices is a complex process, it's not

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Brooktree Corporation, 9950 Barnes Canyon Road, San Diego, California 92121. 1-800-VIDEO IC or 1-800-422-9040, in California.

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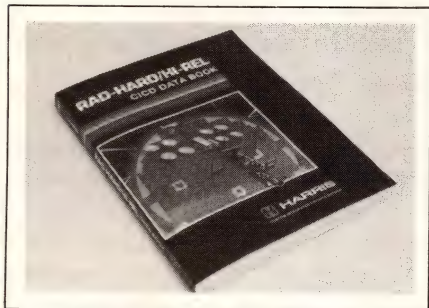


CIRCLE NO 53

too difficult to maintain high device yields once you understand the various contributing factors.

ILC Data Device Corp, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 660



Data book details rad-hardened products

This book provides technical specifications on the company's rad-hardened products. Containing 496 pages, it features data sheets on such products as CMOS 16k-byte static RAMs, 80C85 and 80C86 microprocessors and peripherals, operational amplifiers, analog switches, comparators, multipliers, and data-communications interface devices. In addition, a section covers the manufacturer's CMOS/analog/digital standard-cell library, which includes 32 individual cells. The data book features other sections pertaining to microwave gallium arsenide products, secure-communication ICs, the effects of radiation on CMOS, and die sales and ordering information.

Harris Corp, Semiconductor Sector, Box 883, Melbourne, FL 32901.

Circle No 658

Specs on ICs

The eighth edition of *Modules/Hybrids* provides device specifications on more than 11,500 linear and digital hybrid ICs and modules from 84 manufacturers worldwide. This edition covers nearly 1000 new parts and contains updated information on another 500. In addition, it references many new sources for these off-the-shelf hybrid ICs and mod-

ules. Sample products include wide-band amplifiers, synchro-to-digital and digital-to-synchro converters, operational amplifiers, A/D and D/A converters, active filters, oscillators, and overvoltage-protection devices. Logic/circuit drawings and outline drawings complete the treatment. \$95.

DATA Inc, Box 26875, San Diego, CA 92126.

INQUIRE DIRECT

Brochure details attributes of power FET

This 4-pg brochure details the characteristics of the company's static-induction-transistor (SIT) field-effect transistors (FETs). It lists features and applications and also presents charts of electrical characteristics and absolute maximum ratings. Finally, the brochure illustrates the package dimensions.

Tokin America Inc, 2261 Fortune Dr, San Jose, CA 95131.

Circle No 662

Handbook aids in design of CMOS gate arrays

The Programmable Gate Array Design Handbook is available to system designers who are interested in CMOS user-programmable gate arrays and development systems. The 288-pg book explains how to implement designs using the company's programmable gate arrays and how to reduce design time. It includes a listing of design examples.

Xilinx Inc, 2069 Hamilton Ave, San Jose, CA 95125.

Circle No 661

Publication discusses specs for analog ICs

The *Elantec 1987 High Performance Analog Data Book* presents complete technical specifications for the company's high-speed analog ICs. The book is organized into six chapters of data sheets; selection

guides precede each chapter. Additional chapters provide information about the manufacturer's reliability and quality-assurance programs, and its monolithic and hybrid military IC processing programs. Package outlines are also included. Request the book on company letterhead.

Elantec Inc, Marketing Communications, 1996 Tarob Ct, Milpitas, CA 95053.

INQUIRE DIRECT

Linear applications

The 350-pg manual, *Linear Applications Handbook: A Guide to Linear Circuit Design*, is written for system designers. Various chapters in the 360-pg book cover 3-terminal regulators, applications of switched-capacitor-instrumentation building-block circuits, thermal techniques in measurement and control circuitry, and direct digitization of transducer outputs. Other chapters discuss high-speed comparator techniques, design of linear functions for 5V-only operation, and high-performance voltage-to-frequency converters. All applications include the schematics and parts values for the circuits described. \$9.95.

Linear Technology Corp, 1630 McCarthy Blvd, Milpitas, CA 95035.

INQUIRE DIRECT

Handbook covers motion and power control

The 287 pages of application notes in the 1150-pg *Motion Control Applications Manual* include discussions on stepper-motor drives, dc motor drives, solenoid drivers, and switch-mode power supplies and power converters. Other application notes cover the use of power transistors, fast recovery diodes, and power integrated circuits. The application notes are preceded by short selection guides, which help you to choose from the company's range of motor-control and power-supply

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Density	Organization	Part No.	25	35	45	55	70	85	100	120	150	PDIP	SOIC	SQU
16K	16K X 1 4K X 4	M5M21C67 M5M21C68	
64K	64K X 1	M5M5187 M5M5187A	.	.		.	.					.		.
	16K X 4	M5M5188 M5M5188A M5M5189A	.	.		.	.					.		.
	8K X 8	M5M5165 M5M5178		.	.	.	.		.	.	.	.	.
72K	8K X 9	M5M5179	.	.	.	.						.
256K	256K X 1	M5M5257	.	.	.	.						.		.
	64K X 4	M5M5258	.	.	.	.						.		.
	32K X 8	M5M5256 M5M5255 M5M5256A				.	.	.	.	.	.	.	.	.
1M	128K X 8	MH12808TNA					.	.	.	.	.
2M	256K X 8	MH25608S1N			.	.	.	.	.	.	.

*PDIP: Plastic Dip SOIC: Small-Outline Gull-Wing SOJ: Small-Outline J-Lead

or SOJ (small-outline J-lead) for surface mount designs.

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CIRCLE NO 160

LITERATURE

ICs. Full data sheets for all of these devices are contained in the last section of the handbook.

SGS Microelettronica SpA, Via C Olivetti 2, 20041 Agrate Brianza, Italy.

Circle No 664

Catalog delineates integrated circuits

The 150-pg *Integrated Circuits Catalog 1987* provides general information on the company's range of integrated circuits. The general-purpose-IC section includes several logic families, memories, analog and digital ICs; the special-purpose-IC section includes devices for use in radio, audio, video, video games, telephony, and general industrial applications. Other sections cover μ Ps, microcontrollers, and both gate-array and standard-cell semicustom ICs.

Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands.

Circle No 663

Switches and multiplexers covered in a catalog

This manufacturer's 1986 catalog contains data sheets and applications information on 50 products, including an entire line of CMOS analog switches and multiplexers. The 82-pg book also documents some product advances, including the improvements in the multiplexers' overvoltage fault protection that continue to protect input and output signal sources after the removal of power; and the reduced power consumption and elimination of extra logic supplies on virtually all second-source analog-switch products.

Maxim Integrated Products, 530 N Pastoria Ave, Sunnyvale, CA 94086.

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Library of handbooks

This company's 1987 technical library of process-measurement handbooks consists of five books that address pressure, strain, and force; temperature; flow and level; pH and conductivity; and test instrumentation and tools. Each book contains specification information, reference sources, technical guidance, and pricing.

Omega Engineering Inc., Box 4047, Stamford, CT 06907.

Circle No 638



Catalog presents interconnect devices

This 84-pg catalog features the company's line of interconnection products. The sockets and adapters are available in SIPs, DIPs, zig-zag configurations, and over 150 low-insertion-force, pin-grid-array footprints. The catalog covers new products such as hybrid sockets with surface-mounted components, single- and dual-beam connectors, multilayer wire-wrapped boards, and surface-mount decoupling capacitor sockets. Request *Catalog #7*.

Advanced Interconnections, 5 Energy Way, West Warwick, RI 02893.

Circle No 640

Catalog presents coaxial products

This 25-pg catalog (#187) contains pricing information on the company's coaxial adapters, connectors, attenuators, terminations, and coaxial cable assemblies (flexible and semirigid). In addition, the catalog

covers twin-axial adapters and connectors.

Pasternack Enterprises, Box 16759, Irvine, CA 92713.

Circle No 639

Test-and-measurement accessories cataloged

Publication No 5954-0193D describes this company's test-and-measurement accessories that are available in the US by phone order for same- or next-day shipment. The catalog is organized into four sections: accessories and cables, rack mounts and cabinets, supplies, and instruments. It lists products alphabetically, numerically, and by equipment reference. The catalog also contains selection guides, flow diagrams, and compatibility charts to help you find the right products for a particular application.

Hewlett-Packard Co., 1820 Embarcadero Rd, Palo Alto, CA 94303.

Circle No 641



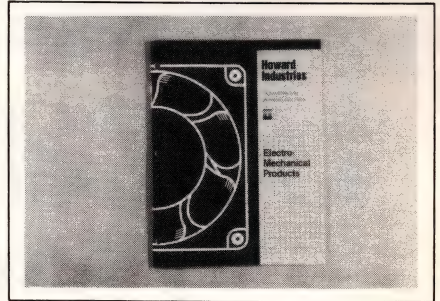
Learn the basics of cooling equipment

Catalog 286 details the basics of air-moving devices and accessories necessary for cooling cabinet-mounted electronics equipment. The brochure briefly covers the different types of cooling units and presents photos and pie charts. Next, it discusses the vendor's cus-

tom units and design assistance. Following information on how to choose a cabinet-cooling blower are 27 pages that describe the company's products.

McLean Engineering, Div of Zero Corp, 70 Washington Rd, Princeton Junction, NJ 08550.

Circle No 643



Catalog covers line of electromechanical products

This 22-pg catalog details the mechanical and performance specifications of the Quiet Force fans and blowers. Products highlighted include ac and brushless-dc tube-axial fans, forward-curved centrifugal blowers, and accessories. The catalog illustrates key aerodynamic and acoustic properties and provides air-mover descriptions. It also contains a page of technical definitions, and it's punched for filing.

Howard Industries, 1 N Dixie Hwy, Milford, IL 60953.

Circle No 642

How to evaluate system-level testing

The 5-pg reprint *Measurements on Optical Fiber Systems* discusses the proper evaluation method for subsystem- and system-level testing. It examines fiber-optic-system features such as optical margin, bit error rate, eye diagram, and alarm and redundancy switch-overs. The reprint details the measurements required during the installation and troubleshooting periods.

Intelco Corp., 8 Craig Rd, Acton, MA 01720.

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LITERATURE

EMI/RFI filter connector catalog

The 28-pg *Catalog No 61-04* covers filter connectors meeting all applicable MIL requirements, including MIL-C-5015, MIL-C-83723, MIL-C-26482, and MIL-C-38999. Also included are testing procedures and design considerations for these types of filter connectors. Specifications for a wide selection of BNC and TNC connectors, multisection filters, and Tempest power-line filters are also included.

Murata Erie North America Inc., 2200 Lake Park Dr, Smyrna, GA 30080.

Circle No 644



Catalog details equipment enclosures

The 210-pg catalog entitled *To Each Its Own Housing* outlines the company's range of electronic equipment enclosures and accessories. Products detailed include sectional wall-mounting cases, triple section cases with a special matt finish, shell-type cases, flat-pack cases, handheld boxes with or without battery compartments, desktop cases, keyboard housings, potting boxes, and a range of control knobs. In addition to providing detailed dimensional drawings, the catalog has information on machining methods available to provide custom housings and special screening. It also covers the physical, flammability, and insulation characteristics of

plastics.

Odenwalder Kunststoffwerke GmbH, 6967 Buchen/Odenwald, West Germany.

Circle No 647



Connector catalog

This 24-pg catalog, *EX-HDC-3*, covers the company's Hi-Con high-density connectors. The publication provides specifications and details that allow the user to select connectors that match performance requirements. It discusses the economical Series 135 male and female connectors conforming to DIN specifications. Also included are the Series M connectors, which provide for mixed contacts in the same housing.

Panduit Corp., 17301 Ridgeland Ave, Tinley Park, IL 60477.

Circle No 645

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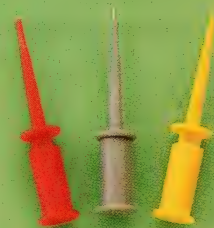
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**SMD TEST TWEEZER™ TO BNC
MALE: MODEL 5142 (SHOWN).
TO TWO SINGLE STACKING
BANANA PLUGS: MODEL 5143**



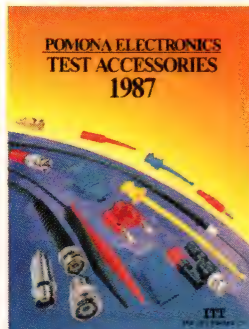
**DO-IT-YOURSELF SMD
GRABBER™: MODEL 5243**



**SMD MICROTIP™ TEST
PROBE TO SINGLE
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PLUG: MODEL 5144**

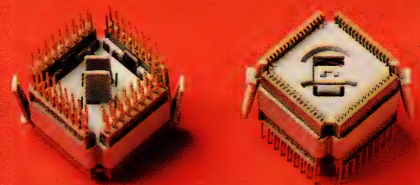


FREE 1987 GENERAL CATALOG



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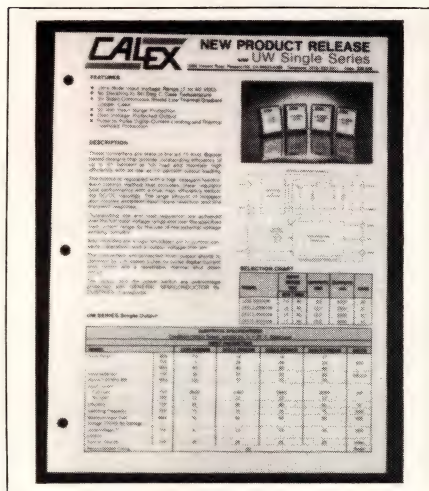
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(16 PIN) SHOWN; 5253 (20 PIN);
5254 (24 PIN)**



**MOLDED BREAKOUT; SMD
GRABBER™ TEST CLIPS TO
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LITERATURE: POWER SOURCES



Data sheet describes dc/dc converters

This 4-pg brochure contains detailed descriptions, specifications, and performance curves for four dc/dc converters, which are suited for use with microwave links, SCADA equipment, weather stations, and navigational systems. The brochure is punched for a 3-hole binding.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523.

Circle No 634

Power-supply catalog

Covering a full line of power supplies, this 24-pg catalog includes the following types of power supplies: open-frame linear and split-bobbin linear; Series V switching; multiple- and single-output switching; and enclosed switching. It provides product features, photos, specifications, output rating charts, and outline and mounting drawings.

Condor Inc, 2311 Statham Parkway, Oxnard, CA 93033.

Circle No 636

Power-supply handbook

The 176-pg engineering manual, *Power Supply Engineering Handbook*, provides electrical and mechanical specifications for more than

2400 standard power-supply products. It includes product specifications, information on the vendor, and a 24-pg tutorial that examines power-conversion principles. The product lines covered in the handbook include open-frame and cased switching and linear power supplies, as well as encapsulated and MIL-spec supplies.

Computer Products Inc, Power Conversion Group, 2900 Gateway Dr, Pompano Beach, FL 33069.

Circle No 635

Power-supply catalog simplifies selection

This full-line catalog simplifies power-supply selection by providing separate guides for all of the firm's single- and multiple-output supplies, including dc/dc converters. The selection guide uses the product model number to specify each unit's input power, voltage, and

POWER PLUS...

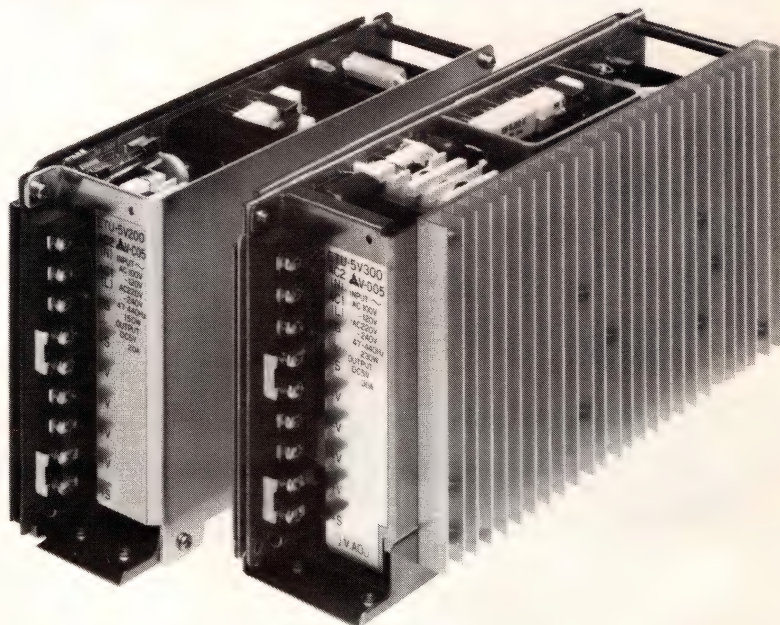
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CIRCLE NO 54



Panasonic Industrial Company

Power Supplies Department
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A new era in power MOSFET performance

HEXFET[®] III

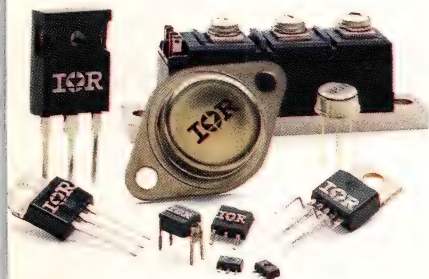
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HEXFET III protection like this lets you forget about zener clamping. And snubber circuits. And series diodes. And any other unnecessary protection components.

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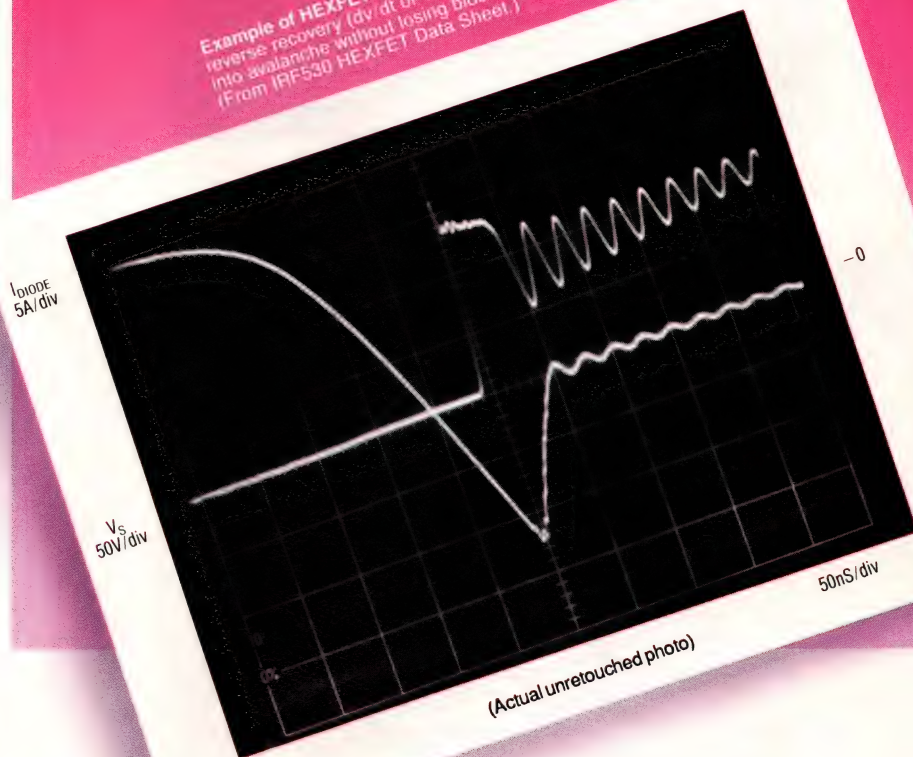
Best of all, HEXFET III performance extends across our complete family of HEXFET power MOSFETs — from 60 volts to our new 1000-volt device.

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Example of HEXFET III Ruggedness: During diode reverse recovery (dv/dt of 15V/ns), device went into avalanche without losing blocking capability. (From IRE530 HEXFET Data Sheet.)



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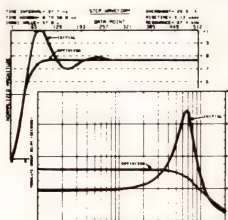
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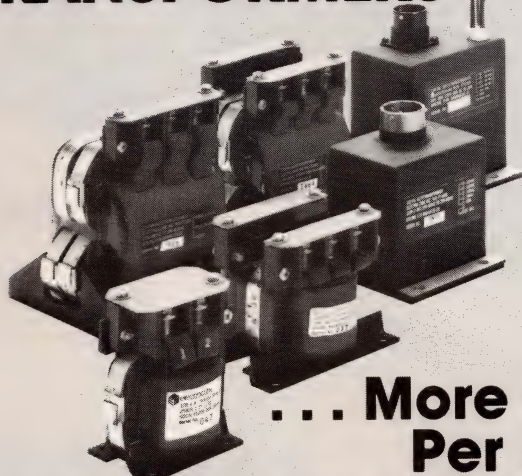
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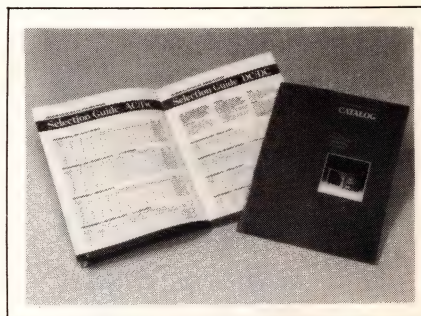


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LITERATURE



main and secondary channel voltage and current output. This catalog is free if requested on company letter-head.

Pioneer Magnetics, 1745 Berkeley St, Santa Monica, CA 90404.

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The Postscript Language Journal is a quarterly publication for users of Postscript, the Adobe Systems page-description language that prints documents on laser printers and phototypesetters. Each issue contains hardware and software reviews, font samples, tutorials on the use of the language, and articles on advanced programming techniques. The language allows you to program your laser printer to merge text and artwork with no paste-up. US subscriptions cost \$15 for one year and \$25 for two years; add \$2 for Canada and Mexico and \$4 for other overseas destinations.

The Postscript Language Journal, Box 5763, Parsippany, NJ 07054.

Circle No 605

Supercomputing software catalog

The *Convex Atlas* is a compendium of third-party application software for the supplier's supercomputer family. The catalog has nine sections, the first eight of which list software that addresses structural analysis; computational fluid dynamics; mathematical libraries; petroleum and seismology undertakings; electronic-circuit simulations; chemistry; graphics; and control-system, mathematical, and econometric simulations. The ninth section covers a wide variety of topics, from astronomical image processing to spreadsheets and word processors.

Convex Computer Corp., 701 N Plano Rd, Richardson, TX 75081.

Circle No 606

Motion-programming language guide

A 32-page booklet documents an upgraded version (3.0) of the vendor's motion-programming language (MPL). The publication contains a complete description of the com-

mands and syntax, and includes some examples that show how you can use the language to create high-performance servo-control systems. It pays particular attention to recent enhancements of the language, such as the Contour-definition command, delay commands, commands for setting overtravel limits under software control, commands for setting special deceleration rates for emergency or overtravel stops, and commands that allow you to display system parameters and status during program execution.

Ormec Systems Corp., 19 Linden Pk, Rochester, NY 14625.

Circle No 607

Journal takes a look at the software industry

Software Strategies is a quarterly journal devoted to the business aspects of software publication. The premiere, March 1987, issue consists of eight double-column pages and examines price elasticity, demo disks as lead generators, software R&D, software copyrights and clones, opportunities for 80386 software development, the implications of section 1706 of the Tax Reform Act for software vendors, software-support technologies, and VARs and VADs and their functions. \$60 a year.

Bowen Consulting, 4684 Blanco Dr, San Jose, CA 95129.

Circle No 608

Report on AI market

1986 AI Market Reports: A Review for the Corporate User is a 3000-pg publication that analyzes the strengths and weaknesses of 10 industry reports. The review evaluates each report and gives it an overall score based on 10 criteria, including the timeliness and accuracy of its information, its value for corporate decision making, and the depth of its technological coverage. Using charts and tables, the compendium compares data from the

various vendors. \$47.50, plus \$2.50 shipping and handling (\$4.50 for overseas orders).

Knowledge Engineering, Box 366, Village Station, New York, NY 10014.

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Information on design-automation software

A videocassette and 6-pg brochure explain the vendor's AutoMate software package for the design of pc boards and hybrids. It describes the tool set, which makes extensive use of expert-system techniques, includes tools for schematic entry, simulation, verification, automatic placement, automatic and interactive routing, and graphics editing. Finally, the brochure lists which machines the tools run on.

Royal Digital Systems Inc., 3600 W Bayshore Rd, Palo Alto, CA 94303.

Circle No 609

Document discusses programming, languages

This 39-pg document addresses the complexities of microprogramming and alternative microprogramming languages. In addition to examining the problems specific to microprogramming and offering traditional and unconventional ways to solve these problems, the publication provides information on the vendor's Metastep language. It includes a discussion of the major components of the language and detailed examples of representative and actual microprograms. Examples illustrate how to embed design-rule constraints within the structure of the language and within macro instructions.

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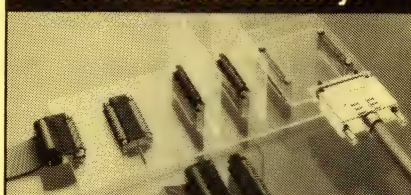


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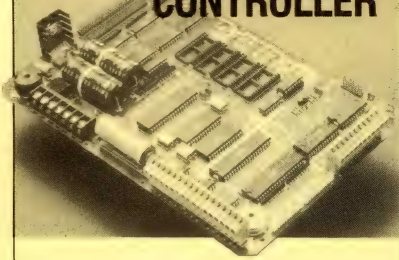
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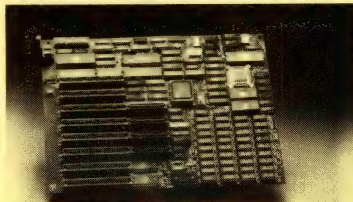
The MAP901 controller offers two serial ports, OPTO22 compatible parallel I/O, real time clock, and 8 analog inputs. This local controller is programmed in Basic and able to execute programs from user selected RAM, EPROM or EEPROM.

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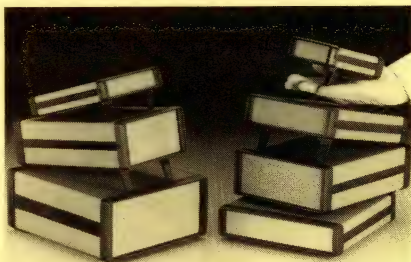
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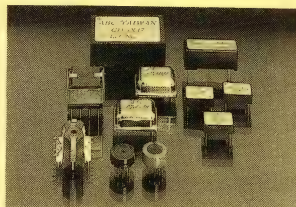
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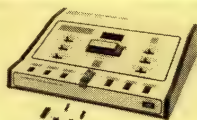
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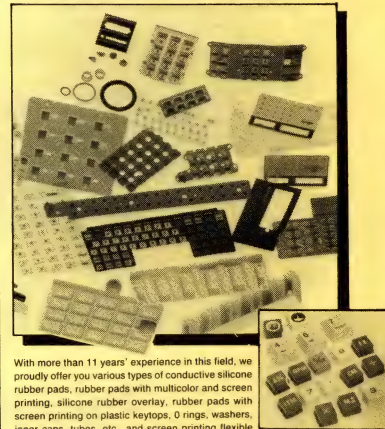


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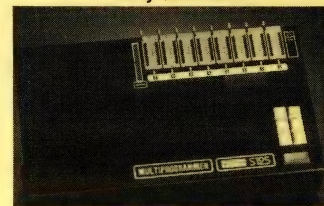
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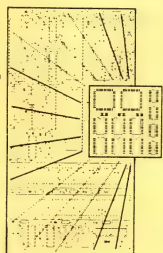
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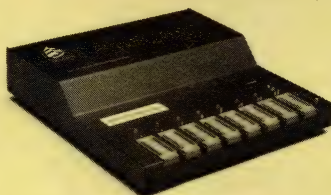
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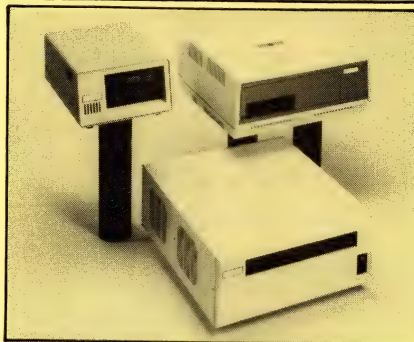
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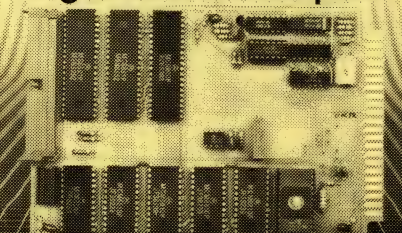
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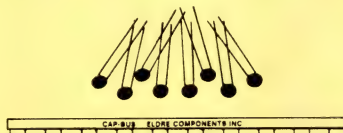
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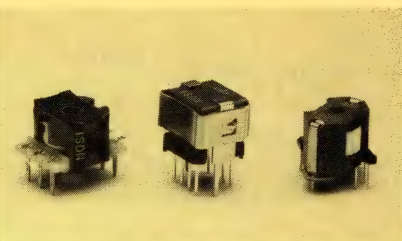


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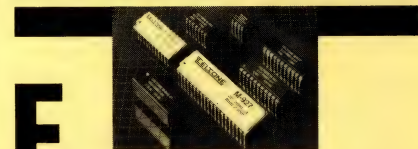


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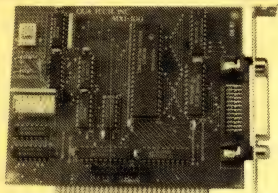


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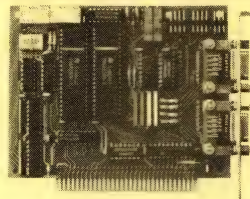
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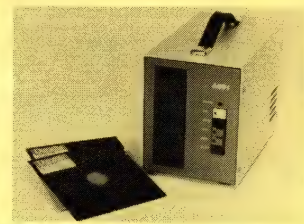
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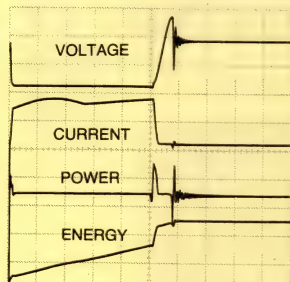
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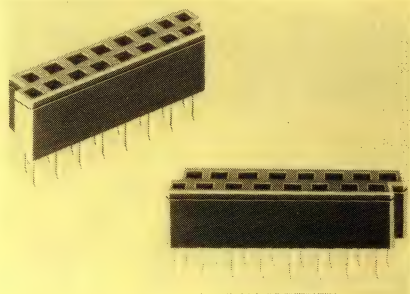
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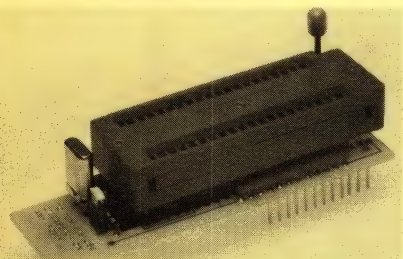
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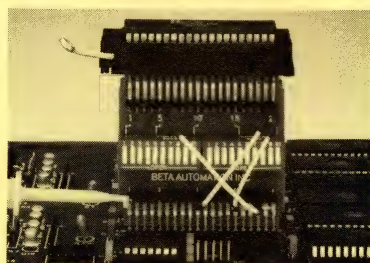
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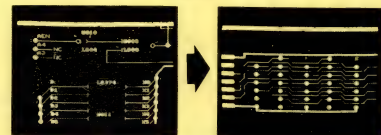


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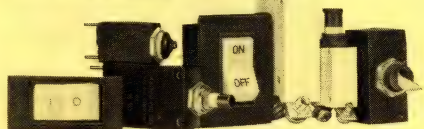
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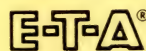


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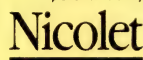
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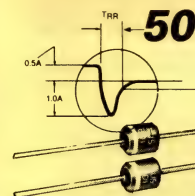


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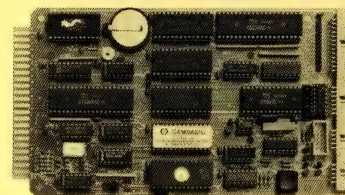


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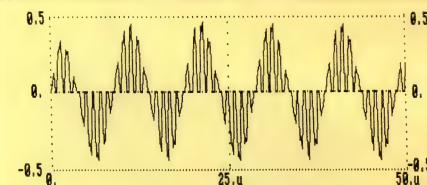
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For three test engineers, Atlantic City's Slot Machines are more than fun and games

Gambling is big business in Atlantic City. More than \$2.5 billion has been invested in the city's casino industry since 1978, when New Jersey legalized gambling in an effort to restore the economy of the once popular seaside resort. Twelve casinos now employ 35,000 area residents, and signs of the restoration efforts are everywhere. Airport posters greet arriving passengers with casino information. Highway billboards announce the latest jackpot winnings. In 1986, casino visitors gambled away \$2 billion.

Unlike other centers of legalized gambling, however, New Jersey heavily regulates its gaming industry and requires casinos to adhere to numerous rules. Each casino, for example, must be located in a hotel of at least 500 rooms. Casino cocktail waitresses are permitted to serve alcohol to gamblers on the playing floor, but they are not allowed to verbally offer any beverages other than soft drinks. The



Engineers (left to right) Ali Ghanavati, Bruce Lampa, and James Maida in their laboratory.

casinos are also bound by strict rules governing internal security. As a result, scores of hidden cameras scan the playing floor; money is carefully counted, recounted, and locked up; and dozens of casino personnel patrol the huge rooms where guests play slot machines, black-

jack, and baccarat.

However, perhaps the most careful watch is kept on the slot machines, which have tempted more than a few gamblers to sidestep chance and to try their luck at rigging an instant jackpot. In 1986, casino patrons spent \$1 billion—half

of the casinos' gross wins—on the 18,000 slot machines in Atlantic City. Policing the casinos and their activities is the job of the 525-person Division of Gaming Enforcement, a department of the New Jersey attorney general's office. Specifically responsible for the slot machines is the Electronic Games Section and its staff of 20.

Tracking the slot machines is no small task. In an office in the Electronics Games Section, a wall map charts the number of machines operating in each casino as well as the number stored in warehouses. It also categorizes the machines according to manufacturer. Each casino's floor map is on file, with each machine's position noted; casino managers must receive the office's approval before changing the location of any machine.

The tracking process has been complicated by the slot-machine industry's switch from electromechanical machines to electronic ones. Embedded microprocessors now spin the reels that turn up cherries, lemons, and the number seven. The first slot machines using 16-bit microprocessors are appearing. Soon, the games will employ fiber optics and application-specific ICs.

Because New Jersey so tightly regulates its oceanside gaming industry, it has become a leader in the testing of slot machines to determine whether they meet state standards. Within the Electronic Games Section, engineers Bruce Lampa, Ali Ghanavati, and James Maida examine the programs that run the city's slot machines to ensure that they are bug-free and that they pay back 83 cents on every dollar played—New Jersey's strictly enforced, minimum payback requirement.

Working in a laboratory a short distance from the waterfront casinos, the men employ two logic development systems, 13 emulation subsystems, and two user-definable

emulator kits to test the equipment. Then, using a high-speed link, they store the information in a main-frame computer. The testing process typically takes anywhere from a few days to several weeks to complete. It is a rare chip, however, that does not need to be returned to its manufacturer. In addition, a program must be retested if the manufacturer modifies it in any way. The engineers tested approximately 500 programs last year.

The engineers also ensure that the programs meet the 83% payback

put themselves in the position of someone interested in tampering with the games. "We look for ways to get to the bus and change data," says Ghanavati. "We also examine what happens when you work on different frequencies, or what happens when static discharge builds up—anything that might change the data."

Despite the improved security that the electronic machines provide, cheaters persevere. In Nevada, a man replaced a slot machine's ROM with one of his own.



Eugene Mopsik

Seventeen 6809 microprocessors run the derby game.

requirement, a service the gambling public should appreciate. Slight shifts in the percentage of payback can cheat slot-machine players out of large sums of money. In one incident in Nevada, it was discovered that more than 30 slot machines were paying at less than 70% and had failed to deliver an estimated \$1 million in winnings.

Thwarting cheaters

The testing process gives engineers an opportunity to search the programs for any loopholes that might allow a cheater to manipulate the programs. Thwarting dishonest gamblers requires the engineers to

When the machine hit for \$1.7 million, he reached around to the back and replaced his chip with the original.

New Jersey has sought to prevent such major instances of fraud by requiring verification of all jackpots greater than \$25,000. Once a player wins a jackpot of this amount, the slot machine shuts down, preventing any tinkering with or further play on the machine. The laboratory employs several field assistants who verify the jackpots, which occur on the average of once a day. They compare the signature analysis of the slot machine that has just been hit with the signature analysis that

is on file for that machine in the computer.

Of equal concern to the engineers are players who want to manipulate a slot machine for a smaller, less dramatic payout. "There are lots of cheaters who would like to milk the machine for \$4000 and then go home," says Ghanavati. "We try to stay one step ahead of them, but with all the whiz kids around, it's not easy."

The lab's scrutiny has made its testing procedures prototypes for other centers of legalized gambling to follow. Representatives from Australia, the Bahamas, Puerto Rico, and the US Navy (which furnishes its officers' clubs with slot machines) have visited the lab to examine its methods.

Last year, the FBI enlisted the lab's services in a case involving a video machine confiscated from a Boston, MA, barroom. Somehow, the machine had been rigged so that the game that appeared on its display screen could be switched from a video game to a gambling poker game. What the engineers discovered was that bar patrons were manipulating the program so as to force it to the illegal poker routine.

Humble beginnings

The lab was not always so efficient. In 1978, the Division of Gaming Enforcement hired Lampa as its first test engineer. "It wasn't even a lab then," Lampa recalls, "it was just a rented trailer." The electro-mechanical games produced in the late 1970s and early 1980s used relay logic, and Lampa was able to test the games without employing an emulator. "Those machines were a lot easier to test; nothing was hidden," says Lampa, who played pinball and operated games on Atlantic City's boardwalk as a teenager. "But when microprocessors started becoming popular, there was nothing we could do but look at pages of the code."

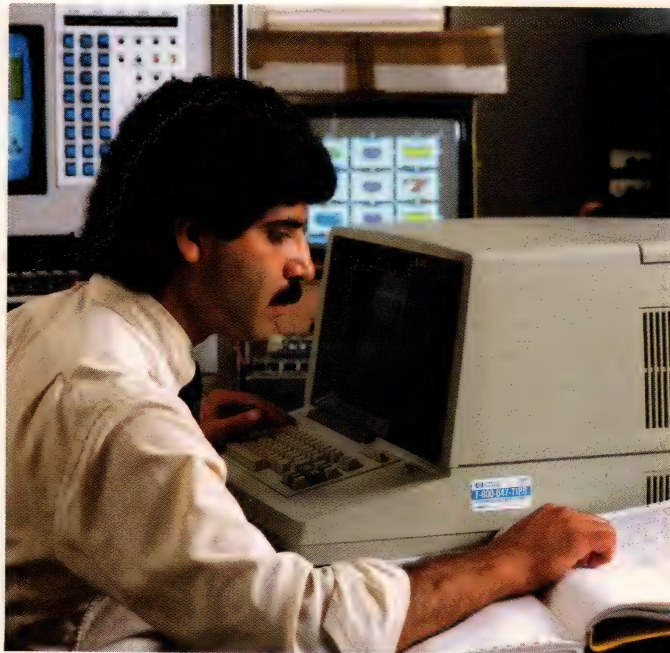
Although the state moved Lampa

out of the rented trailer and into more permanent office quarters, it remained reluctant to spend the money necessary to equip him with tools to test the new microprocessor-backed programs. Lampa was forced to limp along on his own. He purchased a TRS-80 computer and conducted "very crude random sampling."

By the time Lampa hired Ghanavati in 1984, the state had allocated money to outfit the lab with new test equipment. Ghanavati and Lampa began surveying dedicated

wait four years before putting their gaming expertise to work for manufacturers of games used in the Atlantic City casinos. Not surprisingly, they're also prohibited from playing any casino games. Regulations don't bar their families from playing, but as Ghanavati points out, "It wouldn't look very good if my wife went in and won the jackpot."

The red tape of state government also slows down their work at times. By the time one request for \$4000 worth of equipment had made its



Eugene Mopsis

Ghanavati uses a Hewlett Packard 64000 development station to verify a program's operation and payback sequence.

emulation systems. In 1984, they recommended that the state purchase two logic development systems, several emulation systems, and a mainframe computer on which to store the testing information. The equipment has been in use since July 1985. Lampa estimates that the lab now possesses about \$300,000 worth of equipment.

Working in the laboratory has its drawbacks. As civil-service employees, Lampa, Ghanavati, and Maida were subject to extensive background checks before they were hired. And should they ever leave their jobs in the Electronic Games Section, the state requires that they

way through the channels of approval, the manufacturer had lowered the cost. "The state had no way to handle that decrease, so the company had to throw in extra equipment," says Lampa.

Probably the most predictable aspect of the engineers' work is the response it evokes from those hearing about it for the first time: "Everyone asks the same thing," Lampa laments. "They want to know 'How can I win?'"

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Aug. 20	July 30	Military Electronics Special Issue; Fiberoptics; Software
Sept. 3	Aug. 13	Analog ICs; CAE; ASICs
Sept. 17	Aug. 27	Memory Technology; Communications Technology; Software
Oct. 1	Sept. 10	Surface-Mount Technology; Computers & Peripherals; Industrial Product Showcase
Oct. 15	Sept. 24	Test & Measurement Special Issue; Analog ICs; ASICs
Oct. 29	Oct. 8	Computers & Peripherals; ICs & Semiconductors; Wescon '87 Product Preview
Nov. 12	Oct. 22	Wescon '87 Show Issue; ICs; Computers & Peripherals
Nov. 26	Nov. 5	Microprocessor Technology Report & Directory; Analog ICs; Sensors & Transducers
Dec. 10	Nov. 19	Product Showcase-Volume I; ICs and Semiconductors; Software
Dec. 24	Dec. 3	Product Showcase-Volume II; Computers & Peripherals; Test & Measurement Instruments

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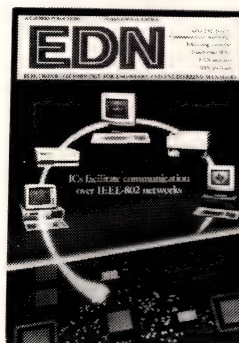
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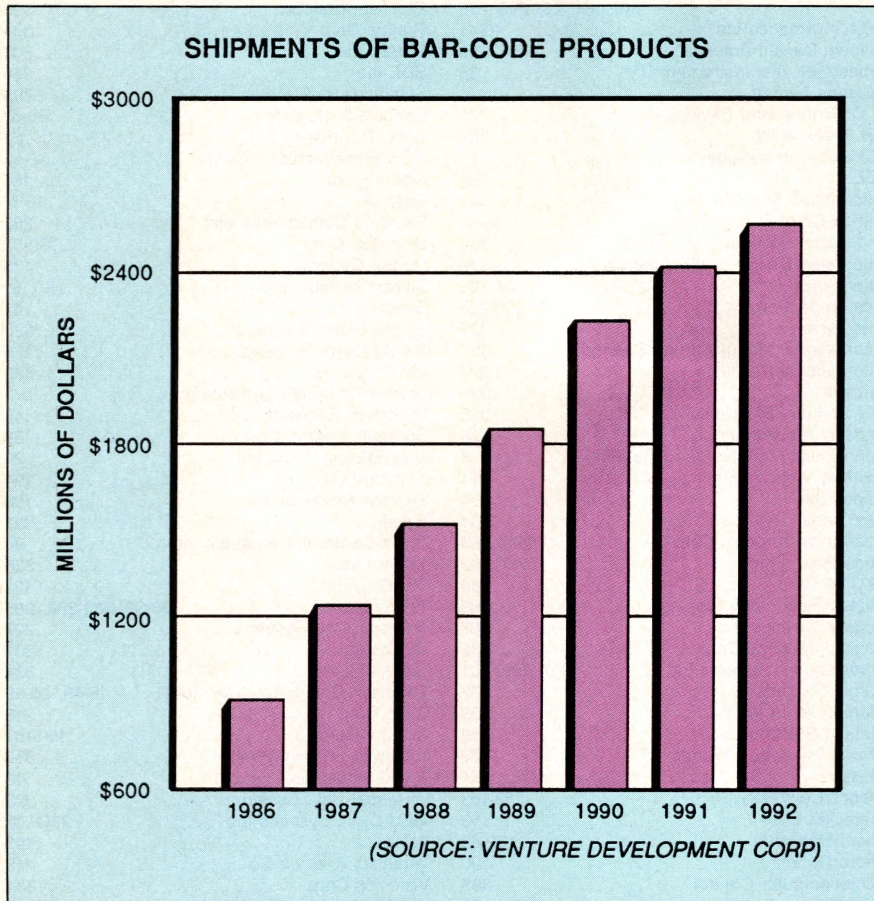
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LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG



Bar-code market to grow 18.6% annually to 1992

The market for bar-code products, which reached \$936 million in 1986, should grow at an average annual rate of 18.6% over the next five years—to produce \$2.6 billion in sales by 1992, according to Venture Development Corp (Natick, MA). This growth will stem not only from those industries that traditionally use bar-code input devices but also from the germination of new uses in soft-goods industries, retail stores, and service sectors such as libraries and health care.

Last year, input devices accounted for the largest portion of revenues from bar-code products. Input devices include portable terminals and handheld devices such as wands and laser scanners.

VDC foresees some significant shifts in the input-device market. Improvements such as faster read-

ing speeds, higher accuracy, increased depth of field, variable focus capability, automatic discrimination of coding symbolics, and greater durability will affect the product mix considerably through 1992.

The market for bar-code printers will undergo corresponding change. Companies will succeed through product refinement rather than through dramatic technological breakthroughs. Producing a high-contrast, dense bar code will be critical for the printer market.

Income from bar-code labels and other consumables is expected to lead bar-code revenues. This development will result in part from even lower prices for these already low-cost products and in part from the increasing density of information available on the labels themselves.

VDC foresees the greatest growth for the bar-code industry occurring

in its smallest market category—software and systems integration. New applications will increase the demand for consulting services, new software, and associated training, debugging, and maintenance.

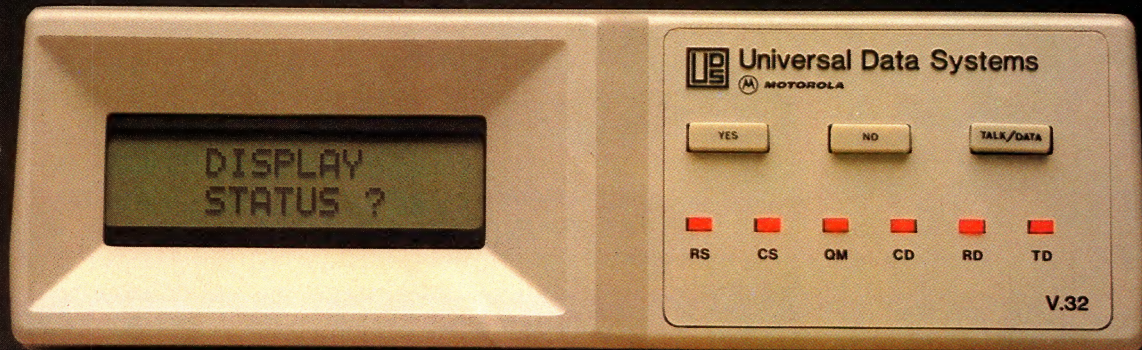
Market for EDI to reach \$1B by 1994

The incipient market for electronic document interchange (EDI) software and services should jump from \$40 million in 1986 to double that figure this year, according to International Resource Development Inc (Norwalk, CT). And by 1994, the worldwide market should soar to above \$1B. Third-party services suppliers, who offer value-added network services for EDI, will benefit considerably from this upward swing. The services provided by these third parties include protocol conversion, validity checking, and batching. IRD predicts that the services vendors will have to step aside, however, when some of their biggest customers choose direct party-to-party EDI, using automatic EDI software packages in mainframes.

Because they will soon be permitted to compete in all value-added markets, the ex-Bell operating systems stand to gain considerably from heightened interest in EDI. But IRD points out that the market is fragmented and complex; it remains to be seen whether the telephone operating companies will appreciate the degree of educational and marketing activity necessary to succeed in EDI today.

As the EDI market grows, the business-forms industry and overnight courier services will suffer the most. In IRD's analysis, the business-forms industry may lose 10% of its revenues to EDI over the next several years, whereas as much as 30% of the overnight couriers' business may be vulnerable to incursion by EDI.

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